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17 July 2023

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Subject: Modification of the Approved Groundwater Remedy for the Plant Site at the Colstrip Steam Electric Station in Colstrip, Montana

Dear Sarah:

Geosyntec Consultants, Inc. (Geosyntec) on behalf of Talen Montana, LLC (Talen Montana) has prepared this letter to request a modification of the approved groundwater remedy for the Plant Site at the Colstrip Steam Electric Station (CSES) in Colstrip, Montana.

On 30 October 2018, the Montana Department of Environmental Quality (MDEQ) approved the Revised Plant Site Remedy Evaluation Report,[1] which identified Alternative 4 as the preferred remedy for groundwater impacts from the Plant Site ponds containing coal combustion residuals (CCR) and process wastewater. Alternative 4 includes (among other components) implementing closure-in-place (capping) for select Plant Site ponds as source control measures as well as flushing with freshwater from the Surge Pond and increased groundwater capture in specific areas, including around and beneath Units 1 & 2 A Pond (A Pond). The Alternative 4 remedy groundwater model projected that groundwater cleanup criteria (CC) would be met by 2049. Based on this remedy selection, the A Pond was closed in place in 2019, the freshwater flushing and groundwater capture system components of the approved remedy were constructed and began operating in July 2020, the Units 1 & 2 Bottom Ash Ponds and Clearwell were scheduled to be closed in place in 2022, and the Units 1 & 2 B Pond (B Pond) was scheduled to be closed in place in 2023.

On 4 January 2023, Talen Montana submitted an Interim Update on the Colstrip 1&2 Plant Site Closure Evaluation. As part of that update, Talen Montana identified that it would perform further evaluation of source control measures for the Units 1 & 2 Bottom Ash Ponds and Clearwell, A Pond, and B Pond. The locations of those ponds, which are referred to collectively herein as the 'existing U12 impoundments,' are shown on **Figure 1**. Talen Montana submitted an Alternatives Analysis Report[2] that presented the results of the further evaluation to MDEQ on 1 May 2023.

[1] Geosyntec, 2018. Revised Remedy Evaluation Report, Plant Site, Colstrip Steam Electric Station, Colstrip, Montana. Geosyntec Consultants, Inc., Columbia, Maryland. August 2018.
[2] Geosyntec, 2023. Alternatives Assessment Report, Plant Site U12 Impoundments, Colstrip Power Plant, Colstrip, Montana. Geosyntec Consultants, Inc., Columbia, Maryland. May 2023.

This letter has been prepared in response to a letter received from MDEQ on 18 May 2023 and follow up conversations with MDEQ, Talen Montana, and Talen Montana's consultants. MDEQ requested that Talen Montana provide technical details and support for modifying the approved remedy (modified remedy referred to as Alternative 4B) to include closure by removal, and demonstrate that the modified remedy can meet the Remedial Action Objectives (RAOs) as approved. This letter provides a summary of the RAOs, the rationale for modification of the approved remedy, a description of the modified remedy, a comparison of the performance of the approved and modified remedies, and discussion of implementation of the modified remedy.

SUMMARY OF REMEDIAL ACTION OBJECTIVES

This section summarizes the RAOs that have been used to screen remedial action technologies and to evaluate remedial action alternatives for the Plant Site area. The Revised Plant Site Remedy Evaluation Report discussed how the selected remedy (Alternative 4) would meet the RAOs.

Cleanup Criteria

The groundwater remedy for the Plant Site is intended to achieve the CC for the constituents of interest (COIs) presented in the Revised Cleanup Criteria and Risk Assessment Report[3] that was conditionally approved by MDEQ on 27 November 2018 and re-submitted to MDEQ on 20 December 2018 with minor changes to address MDEQ comments. The Revised CCRA Report provides CC for each COI (boron, sulfate, cobalt, lithium, molybdenum, selenium, and manganese) in alluvium, spoils, clinker, coal-related, and Sub-McKay groundwater. As requested by MDEQ, the groundwater remedy also addresses the regulated substances identified in the AOC. The regulated substances identified in the AOC include three of the COIs (sulfate, boron, selenium), as well as potassium, sodium, magnesium, total dissolved solids (TDS) and salinity. The background screening levels (BSLs)[4] are one of the multiple lines of evidence that have been used to assess the effectiveness of remedial alternatives in addressing regulated substances that do not have CC.

Point of Compliance

The edge of the ponds is considered as the point of compliance (POC) for remedy implementation as directed by MDEQ. Select transects representing interim milestones are used as a metric for assessing remedial progress. The transects were developed based on the Resource Conservation and Recovery Act (RCRA) Subtitle D POC, which is 150 meters (approximately 500 feet) from the edge of the pond or the Talen Montana property boundary, whichever is closer.

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[3] Marietta Canty, LLC, 2018. Revised Cleanup Criteria and Risk Assessment Report, Wastewater Facilities Comprising the Closed-Loop System, Plant Site Area, Colstrip Steam Electric Station, Colstrip, Montana, 20 December 2018.

[4] Neptune and Company, Inc., 2017. Final Report on Updated Background Screening Levels, Plant Site, 1&2 SOEP and STEP, and 3&4 EHP, Colstrip Steam Electric Power Station, Colstrip, Montana. 15 May 2017.

Source Control

The RAOs for Source Control Components of the approved remedy are to:

> "control future release of COIs to the groundwater to the extent necessary to achieve the cleanup levels at the downgradient point of compliance in a reasonable period of time."

Seepage from ponds at the Plant Site has been the main source of constituents to groundwater. The existing underdrains and sumps in B Pond, Units 1 & 2 Bottom Ash Clearwell, and former Brine Pond D4, and the ash dewatering trench in A Pond, are source control measures designed to intercept seepage and reduce the flux of groundwater constituents to downgradient (distal) areas. Added Source Control Components of the approved remedy are intended to significantly reduce future seepage of process wastewater from several ponds.

Migration Management

The RAOs for Migration Management Components of the approved remedy are to:

> "Prevent potential current and future exposure of human and ecological receptors to COIs at concentrations greater than cleanup criteria in groundwater beyond the point of compliance, and in surface water in East Fork Armells Creek, and to restore water quality to Cleanup Criteria or background, whichever is greater, in a reasonable period of time."

The Migration Management Components of the approved remedy are intended to significantly decrease the effects of long-term seepage and achieve CC at the POC of affected groundwater within reasonable timeframes.

Institutional Controls

Existing or new institutional controls including city ordinances, deed restrictions, easements, reservations, covenants, controlled groundwater areas (CGWAs), or zoning restrictions, may be implemented at the Plant Site and/or off-site to contribute to controlling potential exposure to groundwater constituents until such time when the remedy has achieved the CC. Permissions from landowners in areas where groundwater may be impacted, and/or governmental bodies with jurisdiction in those areas, would be needed to implement institutional controls. The RAO for institutional controls is to alert potential receptors to the presence of groundwater constituents and to reduce or eliminate potential exposure.

RATIONALE FOR MODIFICATION OF APPROVED REMEDY

The Alternative 4 remedy groundwater model, that was approved by MDEQ, did not focus on the potential for groundwater interaction with CCR material and assumed that solutes were not leaching COIs from the U12 impoundments after closure in place that would impact groundwater above the CC. NewFields updated the source concentrations for the U12 impoundments in the fate and transport model in 2023 using site-specific boron and sulfate concentrations derived from the results of leaching tests conducted on CCR material collected from the Units 1 & 2 Bottom Ash Ponds in March 2022.

The updated fate and transport model was re-run for the closure in place option, and documented in the Plant Site Closure Options Modeling Memorandum that was included as Appendix A of the Alternatives Assessment Report that submitted to MDEQ in May 2023. The closure in place option was referred to as Alternative A in the April 2023 Modeling Memo and included the same remedy components and schedule as MDEQ-approved Alternative 4, but was run with the updated source concentrations in the model. Boron was the only constituent simulated in the updated model for Alternative A because the results of the leaching tests conducted on CCR material from the Units 1 & 2 Bottom Ash Ponds showed that concentrations of sulfate leached from the ash were below the CC (3,000 milligrams per liter [mg/L]; April 2023 Modeling Memo).

The modeling results for Alternative A are discussed in Alternatives Assessment Report – Plant Site U12 Impoundments[5] that was submitted to MDEQ in May 2023, along with modeling results for five additional source control alternatives that were evaluated. The analysis presented in the Alternatives Assessment Report concluded that closure in place, or Alternative A (which was approved by MDEQ), remains a viable alternative. However, rebounding of the water table into the bottom few feet of CCR material closed in place in the former U12 impoundments after the flushing/capture system is shut down would cause the boron plume to reemerge below and slightly downgradient of the existing U12 impoundments.

Talen Montana is recommending that the approved remedy be modified to include closure by removal of the existing U12 impoundments to two new Plant Site landfills (Alternative 4B[6]), which would be effective in reducing the mass of boron and volume of groundwater above CC across the entire Plant Site after cessation of freshwater flushing and groundwater capture. Even though the water table is predicted to rebound after the flushing/capture system is shutdown, a minimum of 5-foot separation distance with the bottom of the two new landfills and the water table would be maintained through 2150 (100 years after the cessation of flushing/capture system operation) under Alternative 4B.

MODIFIED REMEDY

Alternative 4B is a long-term closure option to remove the CCR and the affected soil, if any, in and around the existing U12 impoundments and dispose of these in two new CCR Rule compliant disposal units (Landfill 1 and Landfill 2) at the Plant Site area. The proposed locations of Landfill 1 and Landfill 2 are shown on **Figure 1**.

This alternative would require the construction of two new landfills at the Plant Site. Of the proposed landfills, Landfill 1 would be constructed by expanding an existing triangular depression east of B Pond where the former Units 1 & 2 Bottom Ash Ponds were located while Landfill 2 would be constructed within the footprint of the existing U12 impoundments. The triangular depression was created when solids were removed from the former Units 1 & 2 Bottom Ash Ponds

[5] Geosyntec, 2023. Alternatives Assessment Report – Plant Site U12 Impoundments, Colstrip Power Plant, Colstrip, Montana. Geosyntec Consultants, Inc., Columbia, Maryland. 1 May 2023.
[6] Alternative 4B was referred to as Alternative B in the April 2023 Modeling Memo.

in 2016. Alternative 4 included removing the remaining solids from the former Units 1&2 Bottom Ash Ponds, which would still be completed under Alternative 4B during the construction of Landfill 1. A soil sampling plan for the former Units 1&2 Bottom Ash Ponds removal was included in the Final Remedial Design/Remedial Action (RD/RA) Work Plan.[7] That soil sampling plan would be updated to include the U12 impoundments to identify affected soil, if any, that would require removal and disposal in the two new landfills.

These proposed landfills would meet the design requirements of the CCR Rule and would provide for approximately 1.7 million cubic yards (mcy) of disposal capacity, thereby accommodating the CCR in the existing U12 impoundments as well as allowing for the potential disposal of affected soils.

As sequencing is important in this alternative, construction is proposed to take place in stages. In Stage 1 (**Figure 2**), Landfill 1 would be constructed at the site. In Stage 2 (**Figure 3**), CCR removal would begin at the Units 1 & 2 Bottom Ash Ponds and Clearwell and progress south until Landfill 1 has been filled. In Stage 3 (**Figure 4**), as the Units 1 & 2 Bottom Ash Ponds and Clearwell area is cleared of CCR and affected soil, the construction of Landfill 2 would begin at the location of the Units 1 & 2 Bottom Ash Ponds and Clearwell. By constructing Landfill 2 in cells, additional disposal capacity would be added. In Stage 4 (**Figure 5**), the CCR removal progresses further south until all CCR has been removed from the existing U12 impoundments area and placed in Landfill 2. Landfills 1 and 2 would be closed upon reaching capacity or the final removal of CCR. Remaining areas not occupied by Landfill 2 would be reclaimed.

As the base grades of CCR (shown in **Figure 6**) are only best estimates, if CCR is found to be past the base grades, horizontally or vertically, CCR removal would continue in the associated direction to remove any visible CCR.

It is estimated that constructing, filling, and closing the landfills can be completed over three construction seasons, with construction and filling of Landfill 1 in 2024, construction and filling of Landfill 2 in 2025, and closure of both landfills and restoration of the clean closed areas in 2026.

Alternative 4B also includes the source control measures from the approved remedy, which includes flushing with freshwater from the Surge Pond and increased groundwater capture around and beneath A Pond and former Brine Ponds D1 – D4. The freshwater flushing and groundwater capture systems began operating in July 2020 and are planned to operate until 2050.

The freshwater flushing system consists of 53 vertical injection wells to inject freshwater from the Surge Pond into alluvium and McKay coal around A Pond, and in the spoils beneath the former Brine Ponds D1 – D4. The groundwater capture system for the approved remedy consists of 58 vertical capture wells and 4 horizontal capture wells. The injected freshwater is intended to increase the flux of groundwater constituents removed by the capture system and achieve CC

[7] Geosyntec, 2019. Final Remedial Design/Remedial Action Work Plan – Plant Site, Colstrip Steam Electric Station, Colstrip, Montana. Geosyntec Consultants, Inc., Columbia, Maryland. 4 October 2019.

within a reasonable period of time. The locations of the flushing/capture system components and monitoring wells at the Plant Site are shown on **Figure 1**.

Implementing closure by removal of the existing U12 impoundments would require decommissioning the following flushing/capture system components in 2024 to mitigate interference with construction and ash removal activities:

- Eight alluvial vertical injection wells (IW13-A, IW50-A, IW40-A, IW29-A, IW41-A, IW28-A, IW42-A, IW6-A), the flushing line connecting the alluvial injection wells to the freshwater flushing system, and the flushing port (FP-04);
- Five McKay coal vertical injection wells (IW12-M, IW36-M, IW25-M, IW26-M, IW-27-M), the flushing line connecting the McKay coal injection wells to the freshwater flushing system, and the flushing port (FP-05);
- Eleven vertical piezometers (AB-24S, AB-23S, AB-22S, AB-21S, AB-20S, AB-25S, AB-26S, AB-27S, AB-28S, AB-29S, AB-30S);
- Nine vertical monitoring wells (160M-CCR, 159S-CCR, 158S-CCR, 157S-CCR, 156SP-CCR, 25SP-2, 177I, 178M, 179SP); and
- One vertical capture well (25R).

There may be other utilities and components of the capture system that would have be decommissioned prior to construction and ash removal activities. These will be identified during the design phase. Additionally, the pumps in the A Pond Dewatering Trench Sump, B Pond Underdrain Sump, and Units 1 & 2 Bottom Ash Clearwell Underdrain Sump would have to be de-energized and removed prior to the excavation.

The two horizontal capture wells under A Pond (HW1-A and HW3-A) would remain active during construction and ash removal activities. After both landfills are closed and the surfaces of A and B Ponds have been reclaimed to prevent ponding, six new vertical injection wells would be installed to replace the decommissioned injection wells and resume freshwater flushing activities. In 2026, four alluvial vertical injection wells (IW55-A, IW56-A, IW57-A, IW58-A) and two McKay coal vertical injection wells (IW59-M, IW60-M) would be installed to re-establish freshwater flushing of constituents under A and B Ponds (Figure 1- inset in Attachment A). A new flushing line and flushing port would be installed to connect the replacement injection wells to the freshwater flushing system.

Similar to the approved remedy, Alternative 4B includes monitored natural attenuation (MNA) to address constituents remaining after the capture system is shut down or to replace portion(s) of the capture system before 2050 if deemed appropriate.

PERFORMANCE

Implementing closure by removal of the existing U12 impoundments in addition to the approved components of Alternative 4, is predicted to reduce approximately the same mass of boron and sulfate and volume of groundwater above CC at the Plant Site. The reduction in the volume of groundwater exceeding the sulfate CC with and without closure by removal is expected to be greater than that of boron because, unlike boron, sulfate is not simulated with sorption to aquifer solids. Thus, sulfate moves more easily in groundwater and is more effectively removed by the groundwater capture wells. As such, the remaining discussion regarding performance focuses on boron.

Alternative 4B would be as effective as Alternative 4 in reducing the mass of boron and volume of groundwater with boron above CC during flushing/capture system operation. Between 2018 (baseline) and 2050 (the end of flushing/capture system operation), the mass of boron in groundwater exceeding CC is predicted to be reduced by 97 percent (5,186 to 5,207 kg) under both alternatives (Table 4 of Attachment A). This is because the capture system under Alternative 4B is predicted to remove 1.67 to 3.9 kilograms per day (kg/day) of boron from groundwater at the Plant Site (Table 3 of Attachment A). The volume of groundwater exceeding boron CC under Alternative 4B is predicted to decrease 92 percent (322 acre-feet) from 2018 to 2050, which is 2 percent (6 acre-feet) less than decrease predicted for Alternative 4 (Table 4 of Attachment A).

Alternative 4B would be as effective as Alternative 4 in reducing the mass of boron and volume of groundwater above the boron CC after cessation of flushing/capture system operation. Between 2050 and 2070 (20 years after the cessation of flushing/capture system operation), the boron mass and volume of groundwater exceeding the boron CC under both Alternatives 4 and 4B are predicted to reduce by 99 percent and 98 percent, respectively (Table 4 of Attachment A). This is because even though the water table is predicted to rebound after the flushing/capture system is shutdown under both alternatives, a minimum of 5-foot separation distance with the bottom of the new landfills and the water table would be maintained through 2150 under Alternative 4B.

The reductions in boron mass and volume of groundwater above the boron CC induced by Alternative 4B are sufficient to achieve boron CC outside pond perimeters in most areas of the site. However, the reductions are not sufficient to achieve boron CC in small, isolated areas west and northeast of the existing U12 impoundments, and beneath former coal piles in the center of the Plant Site by 2050. Those areas of exceedance would also remain under Alternative 4. By 2149, the boron CC would be achieved across the entire Plant Site under Alternative 4B.

Boron mass discharge estimates across fourteen transects (A-A' through N-N') downgradient of Plant Site process ponds also demonstrate the performance of Alternative 4B relative to Alternative 4. Under Alternative 4, the mass discharge of boron across all fourteen transects in 2070 (20 years after the flushing/capture system is shutdown) is predicted to be less than the CC (Table 5 of Attachment A). However, the mass discharge estimates for Alternative 4 likely underrepresent long term boron concentrations with closure in place because they do not take into account the potential leaching of constituents from the bottom few feet of CCR material in A Pond. By 2070

(20 years after the flushing/capture system is shutdown), the technologies implemented under Alternative 4B are predicted to decrease the boron mass discharge crossing transects, except for transects B-B' and E-E', to the extent necessary to achieve the boron CC at the transects. The total boron mass discharge across transects B-B' and E-E' in 2070 would be 0.114 kg/day and 0.0105 kg/day, respectively (Table 5 of Attachment A). Transect B-B' is oriented northwest to southeast, along the plant property boundary less than approximately 150 meters downgradient of the U12 impoundments. Transect E-E' is oriented north to south in the middle of the Plant Site, approximately 150 meters downgradient of Units 3 & 4 Bottom Ash Ponds.

The mass discharge of groundwater constituents leaving the plant property through transect B-B' under both alternatives would be taken into consideration when evaluating the need for MNA and/or institutional controls in areas of the Plant Site that are predicted to remain above CC after 2050. It is important to note that the model-predicted reductions in the mass of boron and volume of groundwater exceeding boron CC under both alternatives do not account for potential permanent removal by MNA processes.

IMPLEMENTATION

The following remedy components have been or would be implemented under Alternative 4B:

- Constructed the planned pond upgrades/closures from 2016 through 2023;
- Dewatered North and South C Ponds in 2018, and placed the water in B Pond for use in Generating Units 1 and 2;
- Constructed the new Brine Concentrator Solids Disposal Area (BCSDA) in 2018 and began operating in 2019;
- Increased the pumping rate of existing vertical capture well 98M in 2018, and continued to operate that well until 2019;
- Sampled the soils beneath the liners in North and South C Ponds in 2019 before construction of the Groundwater Capture Storage Pond (GWCSP);
- Increased the pumping rates of existing vertical capture wells 1D, 55D, 5M, 113M, and 115M (if possible) before the freshwater flushing system began operating in 2020;
- Conducted a geotechnical evaluation in 2019 to assess the possible effects of the planned flushing/capture system on the integrity of select ponds and the Coal Barn, and incorporated recommendations into the Operation and Maintenance Plan for the freshwater flushing and groundwater capture systems;
- Constructed the GWCSP in 2019 and operate it until 2050;

- Conducted a freshwater flushing system pilot test in 2019 following installation of 3 injection wells (IW-4A, IW-37M, and IW-47SP) and 8 monitoring wells (IW4-A-N, IW4-A-S, IW4-A-E, IW37-A-N-S, IW37-M-N-D, IW37-M-S, IW47-SP-S, and IW47-SP-W);

- Installed 13 vertical injection wells along the divider dikes for the U12 impoundments in 2019, and operate those wells from 2020 to 2024;

- Installed 40 vertical injection wells west and north of A Pond and in the vicinity of former Brine Ponds D1-D4 in 2019, and operate those wells from 2020 to 2050;

- Installed two horizontal capture wells below A Pond in 2019, and operate those wells from 2020 to 2050;

- Installed two new horizontal capture wells below the BCSDA and former coal piles in 2019, and operate those wells from 2020 to 2050;

- Constructed a freshwater flushing system and piping network in 2019, and operate the system from 2020 to 2050;

- Conduct a MNA demonstration study in 2023 to 2024;

- Decommission 13 vertical injection wells, two flushing lines and two flushing ports, 20 vertical piezometers and monitoring wells, and one vertical capture well in the footprints for the U12 impoundments and Landfill 1 in 2024;

- Relocate utilities and components of the capture system in the divider dike between A and B Ponds in 2024;

- Sample the clay liner(s) and underlying soils beneath the former Units 1 & 2 Bottom Ash Ponds and the U12 impoundments in 2024 through 2025 to identify affected soil, if any, that would require removal and disposal in the two new landfills;

- Construct and fill Landfill 1, located east of B Pond, in 2024 to dispose of ash from the Units 1 & 2 Bottom Ash Ponds and Clearwell;

- Construct and fill Landfill 2, located in the footprint of the Units 1 & 2 Bottom Ash Ponds and Clearwell, in 2025 to dispose of ash from A and B Ponds;

- Close Landfills 1 and 2 and restore the clean closed areas in 2026 by grading the surface of A and B Ponds with fill material to prevent ponded water;

- De-energize and remove the pumps in the A Pond Dewatering Trench Sump, B Pond Underdrain Sump, and Units 1 & 2 Bottom Ash Clearwell Underdrain Sump before excavation begins; and

- Install six vertical injection wells and a flushing line and flushing port in the vicinity of the U12 impoundments in 2026 after reclamation and operate those wells until 2050.

The Surge Pond is the source of freshwater for the flushing system that has been operating at the Plant Site since July 2020. The freshwater flushing system taps into the existing water supply line from the Surge Pond at the Plant Site. The injection system is equipped with redundant backflow prevention to prevent groundwater from flowing back through the system and into the Surge Pond. Under Alternative 4B the total estimated injection rate for freshwater flushing in the Plant Site area is approximately 147 gallons per minute (gpm) and is not anticipated to negatively affect water levels in the Surge Pond. The fate and transport modeling for Alternative 4B assumes the capture and injection rates would be the same as those presented in the modeling report that was included as Appendix J of the Final RD/RA Work Plan for Alternative 4. Individual pumping rates for replacement wells were simulated in the Alternative 4B model to match the rates for the well that they replace in each lithology.

Samples of freshwater from the Surge Pond were collected from the Units 1 & 2 Clarifier Building at the Plant Site on 27 September 2018 and no exceedances of USEPA Maximum Contaminant Levels (MCLs), MDEQ Circular DEQ-7 (DEQ-7)[8], USEPA tap water regional screening levels (RSLs) and the BSLs were identified. The flushing/capture system included in both Alternatives 4 and 4B will continue to meet the minimum requirements to prevent injection wells from contaminating underground sources of drinking water that are set forth in USEPA Region VIII's 1999 Class V Rule. As indicated in a letter date 29 May 2020, USEPA Region 8 has authorized by rule freshwater flushing at the Plant Site in the manner and locations described in the application Talen Montana submitted to USEPA on 23 April 2020. USEPA Region 8 would be notified of the modifications to the flushing system component of the modified remedy prior to implementing those modifications.

[8] MDEQ, 2017. Circular DEQ-7, Montana Numeric Water Quality Standards. Montana Department of Environmental Quality, May 2017.

CLOSING

Please do not hesitate to contact us if you have any questions regarding the information included in this letter.

Respectfully submitted,

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Attachments:

Figure 1 – Plant Site Groundwater Remediation System and Monitoring Well Network
Figure 2 – Alternative 4B Stage 1
Figure 3 – Alternative 4B Stage 2
Figure 4 – Alternative 4B Stage 3
Figure 5 – Alternative 4B Stage 4
Figure 6 – Base Grades
Attachment A – Plant Site Closure Remedy Modification Modeling

Copies to:

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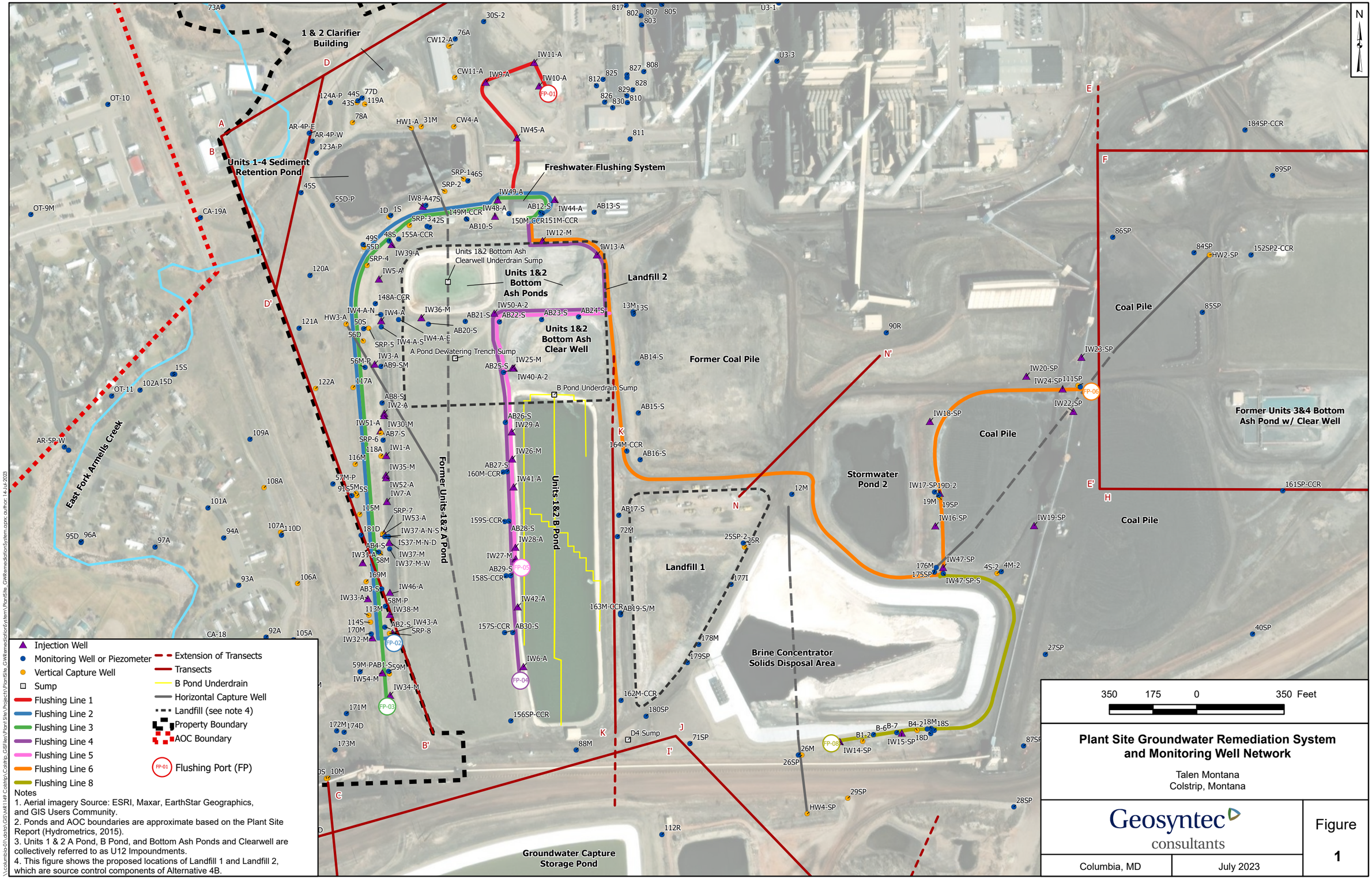

- Injection Well
- Monitoring Well or Piezometer
- Vertical Capture Well
- Sump
- Flushing Line 1
- Flushing Line 2
- Flushing Line 3
- Flushing Line 4
- Flushing Line 5
- Flushing Line 6
- Flushing Line 8
- Extension of Transects
- Transects
- B Pond Underdrain
- Horizontal Capture Well
- Landfill (see note 4)
- Property Boundary
- AOC Boundary
- Flushing Port (FP)

Notes
1. Aerial imagery Source: ESRI, Maxar, EarthStar Geographics, and GIS Users Community.
2. Ponds and AOC boundaries are approximate based on the Plant Site Report (Hydrometrics, 2015).
3. Units 1 & 2 A Pond, B Pond, and Bottom Ash Ponds and Clearwell are collectively referred to as U12 Impoundments.
4. This figure shows the proposed locations of Landfill 1 and Landfill 2, which are source control components of Alternative 4B.

N

350 175 0 350 Feet

Plant Site Groundwater Remediation System and Monitoring Well Network

Talen Montana
Colstrip, Montana

Geosyntec consultants

Columbia, MD | July 2023

Figure 1

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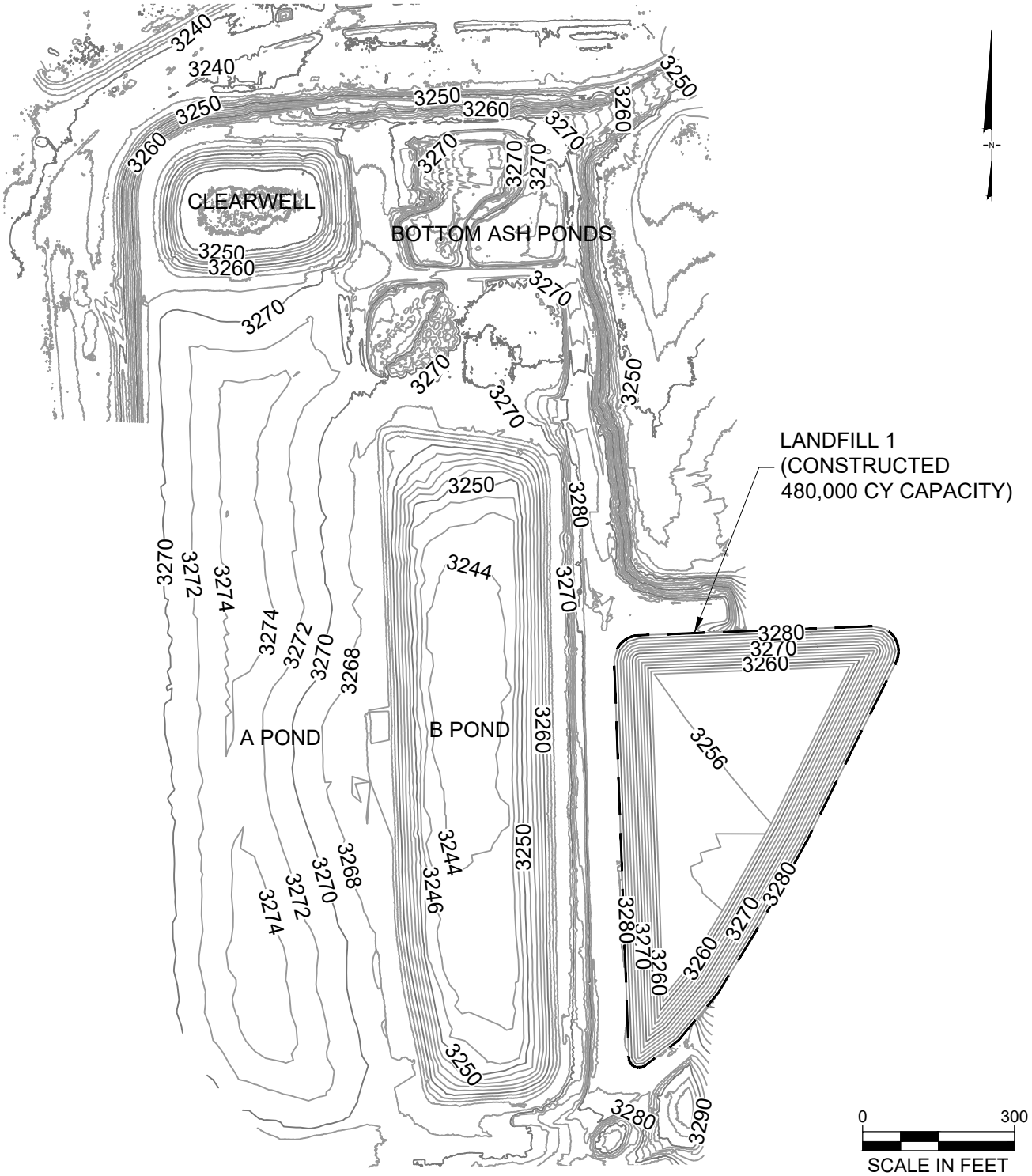

LEGEND

3270 — EXISTING MAJOR CONTOURS

EXISTING MINOR CONTOURS

NOTES:
1. UNDER STAGE 1, LANDFILL 1 IS CONSTRUCTED.
2. ASH REMAINS IN ALL PORTIONS OF THE BOTTOM ASH PONDS, A POND, AND B POND.

ALTERNATIVE 4B
STAGE 1

PLANT SITE U12 IMPOUNDMENTS
COLSTRIP, MONTANA

Geosyntec consultants

FIGURE
2

PROJECT NO: ME1343I | MAY 2023

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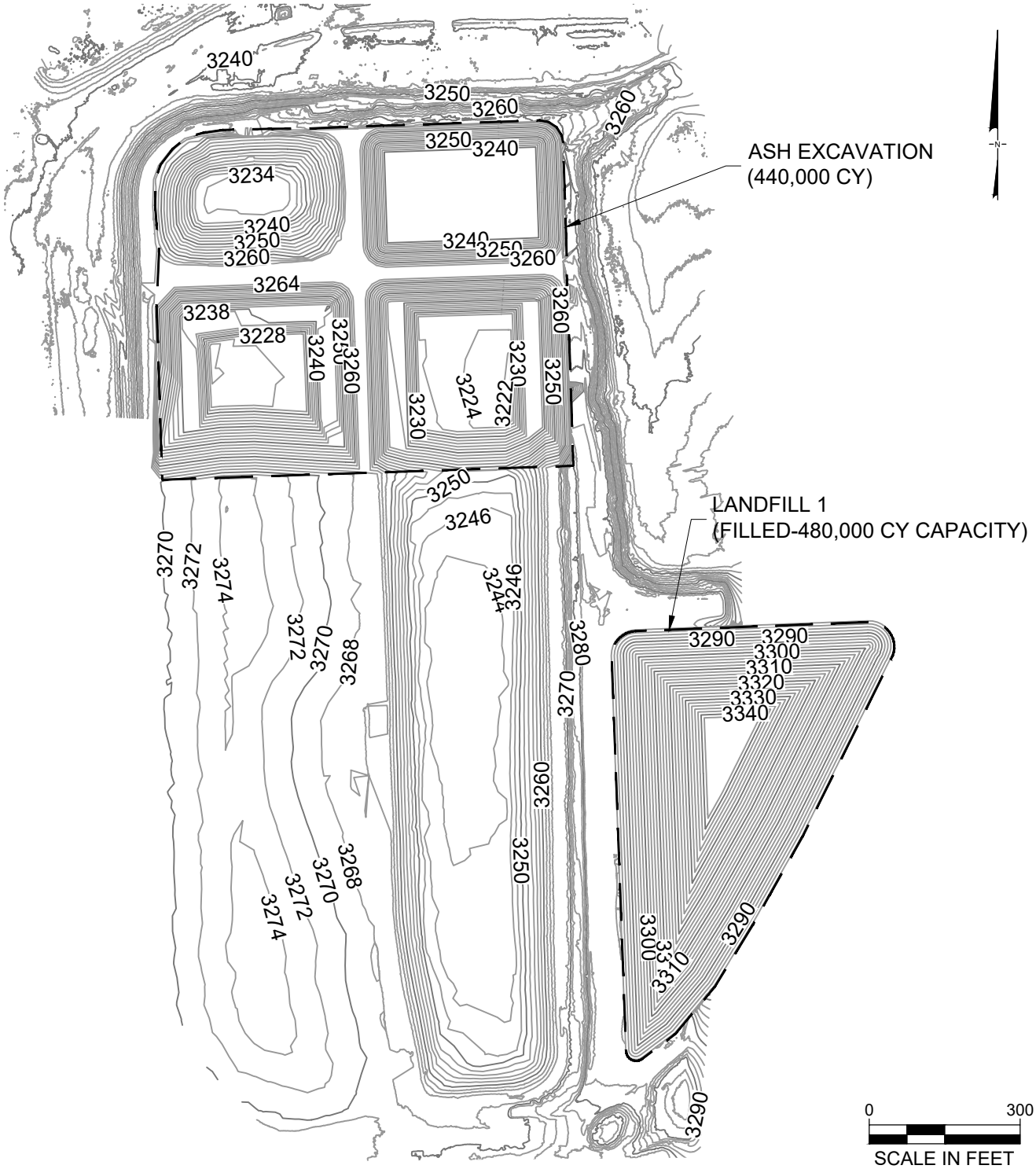

LEGEND

3270 — EXISTING MAJOR CONTOURS

EXISTING MINOR CONTOURS

NOTES:
1. LANDFILL 1 WAS PREVIOUSLY CONSTRUCTED UNDER STAGE 1.
2. UNDER STAGE 2, ASH IS EXCAVATED FROM THE BOTTOM ASH PONDS AND CLEARWELL AND THE NORTHERN PORTIONS OF A AND B PONDS AND PLACED IN LANDFILL 1.
3. ASH REMAINS IN THE SOUTHERN PORTIONS OF A AND B PONDS.

ALTERNATIVE 4B
STAGE 2

PLANT SITE U12 IMPOUNDMENTS
COLSTRIP, MONTANA

Geosyntec consultants

FIGURE
3

PROJECT NO: ME1343I | MAY 2023

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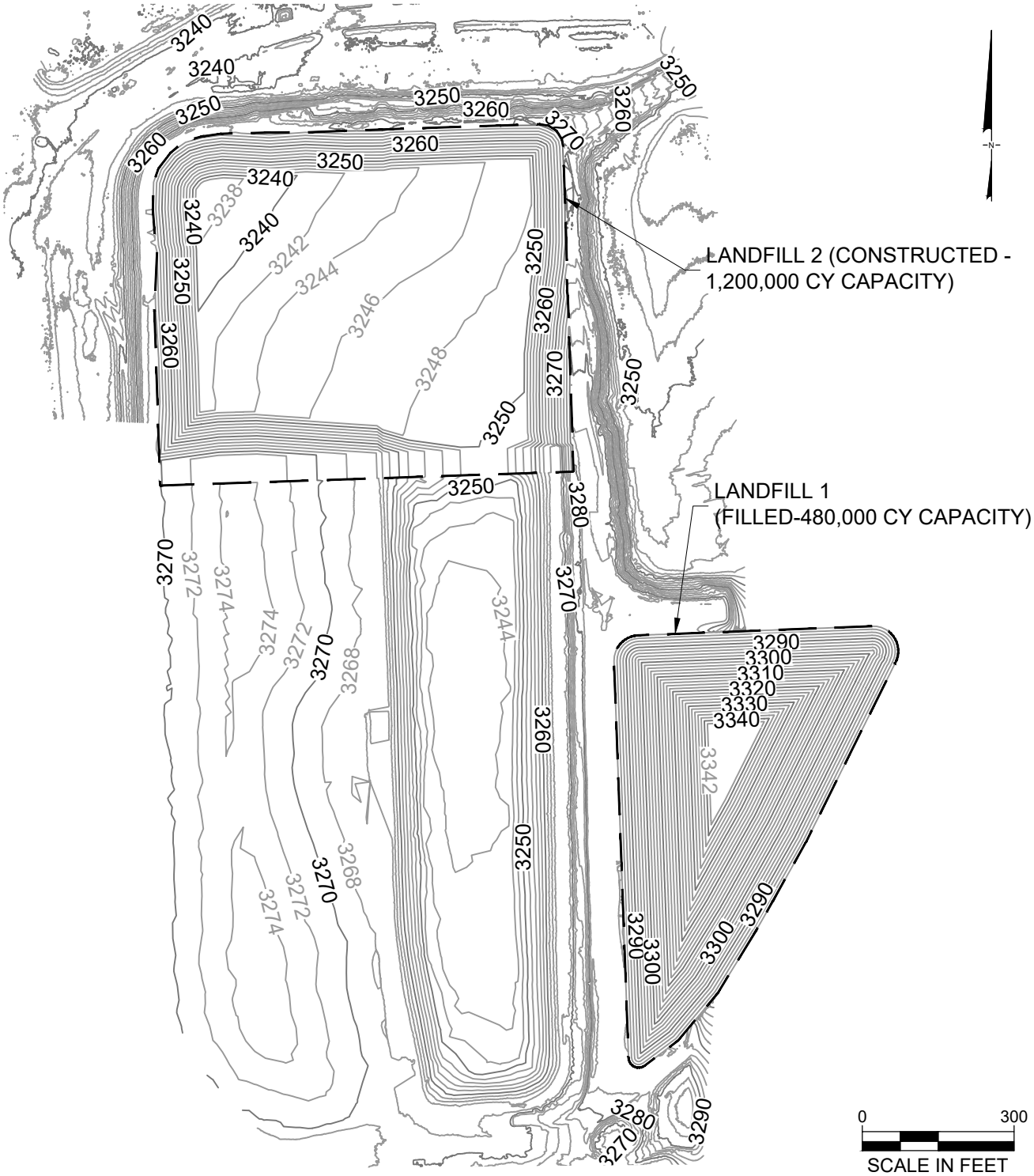

LEGEND

3270 — EXISTING MAJOR CONTOURS

EXISTING MINOR CONTOURS

NOTES:
1. LANDFILL 1 WAS PREVIOUSLY CONSTRUCTED UNDER STAGE 1 AND FILLED UNDER STAGE 2 WITH ASH FROM THE BOTTOM ASH PONDS AND CLEARWELL AND THE NORTHERN PORTIONS OF A AND B PONDS.
2. UNDER STAGE 3, LANDFILL 2 IS CONSTRUCTED.
3. ASH REMAINS IN THE SOUTHERN PORTIONS OF A AND B PONDS.

ALTERNATIVE 4B
STAGE 3

PLANT SITE U12 IMPOUNDMENTS
COLSTRIP, MONTANA

Geosyntec consultants

PROJECT NO: ME1343I | MAY 2023

FIGURE 4

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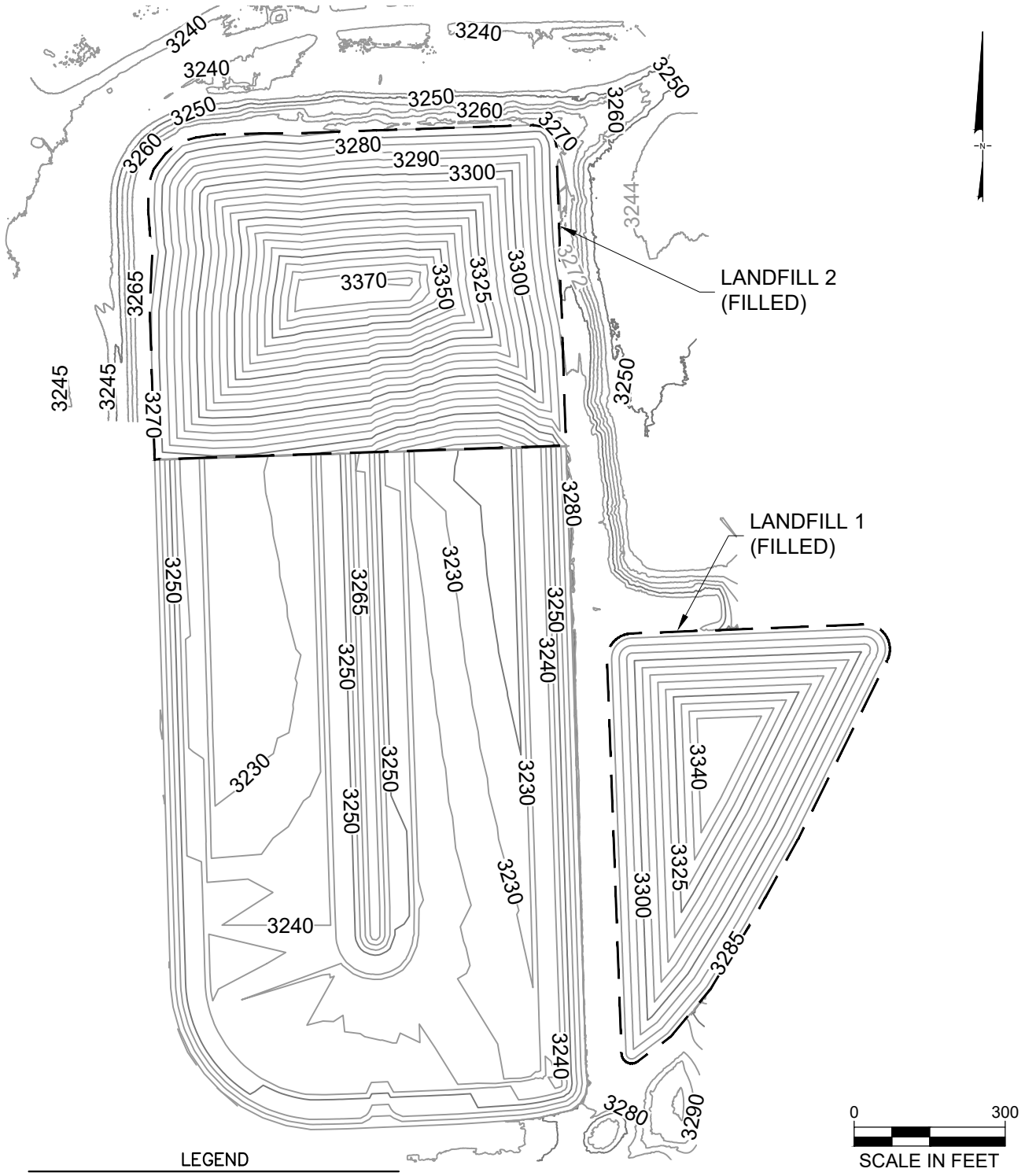

LEGEND

3270 — EXISTING MAJOR CONTOURS

EXISTING MINOR CONTOURS

NOTES:

1. LANDFILL 1 WAS PREVIOUSLY CONSTRUCTED UNDER STAGE 1 AND FILLED UNDER STAGE 2 WITH ASH FROM THE BOTTOM ASH PONDS, CLEARWELL AND THE NORTHERN PORTIONS OF A AND B PONDS.
2. LANDFILL 2 WAS PREVIOUSLY CONSTRUCTED UNDER STAGE 3.
3. UNDER STAGE 4, LANDFILL 2 IS FILLED WITH ASH FROM THE SOUTHERN PORTIONS OF A AND B PONDS. ALL ASH IS NOW IN LANDFILLS 1 AND 2.
4. THE SOUTHERN PORTION OF A AND B PONDS WILL BE SUBSEQUENTLY RESTORED.

ALTERNATIVE 4B
STAGE 4

PLANT SITE U12 IMPOUNDMENTS
COLSTRIP, MONTANA

Geosyntec consultants

FIGURE
5

PROJECT NO: ME1343I | MAY 2023

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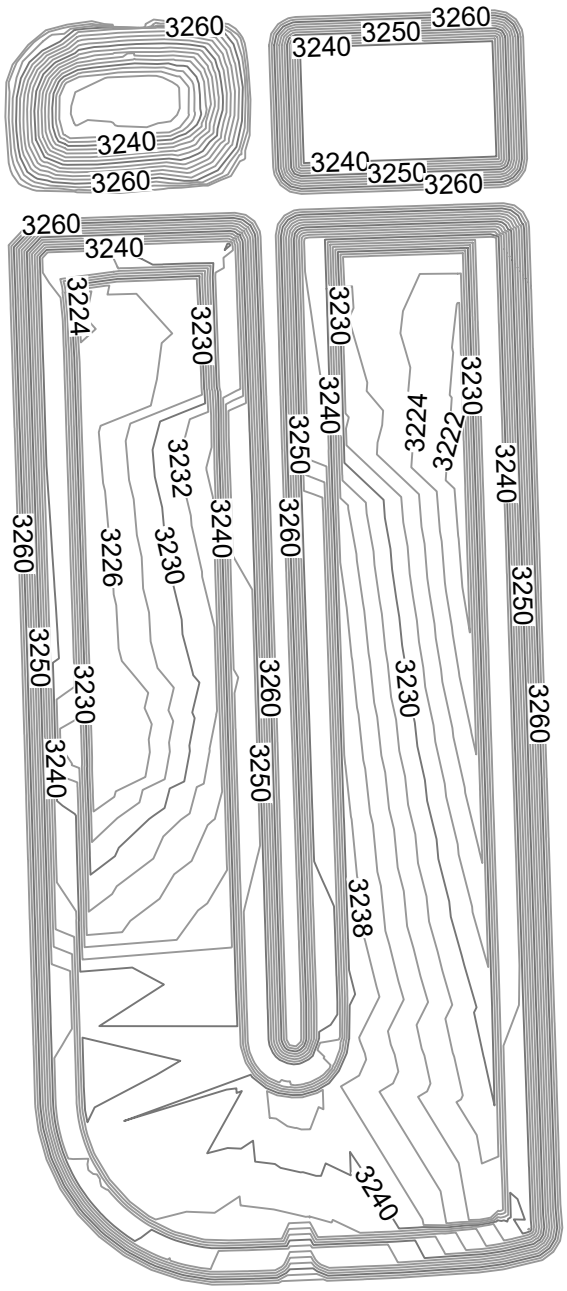

NOTES:
1. BASE GRADES DIGITIZED FROM THE DRAWING C1-31 "BOTTOM AND FLY ASH PONDS PLAN", PREPARED BY BECHTEL, DATED MAY 1974.

BASE GRADES

PLANT SITE U12 IMPOUNDMENTS
COLSTRIP, MONTANA

Geosyntec consultants

FIGURE
6

PROJECT NO: ME1343I | MAY 2023

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ATTACHMENT A

MEMORANDUM

DATE:	June 29, 2023	**PROJECT NO.**	350.0064.005
TO:	Carrie Pendleton -Geosyntec		
CC:	Gordon Criswell and Jennifer Petritz – Talen Energy		
FROM:	Amelia Tallman, Derek Goble - NewFields		
SUBJECT:	**Plant Site Closure Remedy Modification Modeling**		

INTRODUCTION

In response to questions surrounding the potential for constituents to be released into the groundwater system from potential long-term groundwater contact with Coal Combustion Residuals (CCR) material, NewFields revised the Plant Site Remedy model (NewFields, 2019) to include CCR source material within A Pond, B Pond, and 1&2 Bottom Ash Ponds. Based on review of previous model results with respect to groundwater elevations after shutdown of the capture system, portions of these three impoundments may have sustained contact with groundwater. Furthermore, recent leaching studies on CCR material in A pond suggest the CCR in these Plant Site ponds may leach boron at concentrations above the Cleanup Criteria (Canty, 2017).

CLOSURE SCENARIO

Geosyntec has developed a modified preferred closure option (Alternative 4B Closure-by-Removal to New Plant Site Disposal Units) to mitigate the potential for groundwater interaction with CCR material in A Pond, B Pond, and 1&2 Bottom Ash Ponds. NewFields simulated the scenario that includes closure-by-removal of ash in A Pond, B Pond, and Units 1&2 Bottom Ash Ponds into new disposal units at the Plant Site.

This Alternative includes the construction of two new disposal sites on the Plant Site property, adjacent to A and B Ponds (**Figure 1**). Landfill #1, located east of B pond, would be constructed in 2024 and include disposal of ash from the 1&2 Bottom Ash Ponds. Landfill #2, located in the footprint of the former 1&2 Bottom Ash Ponds, would be constructed in 2025 and include disposal of ash from A Pond and B Pond. After excavation, the surface of A and B Ponds would be graded with fill material to prevent ponded water and would receive background recharge.

Changes to Capture System

Construction activities and ash removal would impact existing remedy injection wells. Wells IW-6S, IW-12M, IW-25, IW-26M, IW-27M, IW-28A, IW-29A, IW-36M, IW-40A, IW-41A, IW-42A, and IW-50A would be decommissioned in 2024 to prevent interference with construction and ash removal activities. During this time the B Pond underdrain and horizontal capture wells under A Pond would remain active. After both landfills are closed and A and B Pond surfaces have been reclaimed to prevent ponding, five new injection wells would be installed to replace the decommissioned wells and resume flushing activities. In 2026, IW55-

A, IW56-A, IW57-A, and IW58-A would be installed in shallow groundwater system, and IW59-M and IW60-M in the McKay, to promote additional flushing of constituents under A and B ponds (**Figure 1- inset**).

Model Setup

NewFields updated the fate and transport model with specified concentration boundaries to represent potential leaching from the CCR material. The source concentration set in these boundaries is based on site-specific data. Hydrometrics sampled ash material from the 1&2 Bottom Ash Ponds in March 2022 and analyzed the samples using EPA LEAF method 1316. The leaching test results for boron and sulfate are presented in **Table 1**.

Table 1. Leaching Test Results (EPA Method 1316)

Liquid/Solid Ratio	0.5/1	1/1	2.5/1	5/1	10/1
Boron Concentrations (milligram/Liter)	18.0	17.0	15.0	11.0	9.0
Sulfate Concentrations (milligram/Liter)	2100	2100	1900	2000	2000

The concentrations of sulfate leached from the ash were below the Cleanup Criteria of 3,000 mg/L (Canty, 2017) so no further sulfate transport modeling was conducted. The concentration of boron leached from ash was above Cleanup Criteria, thus NewFields used these boron source concentrations in a solute transport simulation of the remedy. NewFields calculated the forecasted rate of water movement through each pond and the corresponding equivalent liquid to solids ratios. The low permeability of the pond liners results in low flow through the ponds; thus, the equivalent calculated liquid to solid ratio does not increase past 0.5 to 1.

NewFields revised the Plant Site Fate and Transport model to represent expected conditions after the shutdown of the capture and injection system when groundwater levels are expected to rebound. The CCR material is represented as a constant concentration boundary condition within the location of predicted ash saturation within each pond. The constant concentration boundary representing CCR is assigned a boron concentration of 18 mg/L.

The hydraulic conductivities representing pond materials were modified to reflect the permeability of the pond liners based on literature review of similar materials. The hydraulic conductivity of the Clay Liner under A Pond was assigned a value of 3.6E-04 feet per day (ft/day), and B Pond and 1&2 Bottom Ash Ponds were assigned a value of 2.8E-06 ft/day to reflect the double liner.

Aside from the decommissioned wells and replacement wells, the simulation includes capture and injection rates as presented in the RDRA workplan (NewFields, 2019). The individual pumping rates of the replacement wells match the rates for the wells that they replace in each lithology (4 gallons per minute in the shallow system and 3 gallons per minute in the McKay Coal).

The modeling was conducted in stepwise fashion to represent changes to the regraded material within A Pond and B Pond (**Table 2**). In the second stepwise model (beginning in 2026) the hydraulic conductivity of the regraded material was assigned a value of 6 ft/day to be consistent with the surrounding material already in place. Furthermore, starting in 2026 the recharge value through A Pond and B Pond was reverted to background rates and concentrations and the recharge rates through the onsite landfills were assigned a value of 7.55 E-09 ft/day based on estimates from Geosyntec with concentration based on leach test results (18 mg/L). Finally, beginning in 2026, the first stress period of the second model, the replacement wells are simulated to activate.

Table 2. Stress Period Setup Closure-by-Removal to New Plant Site Disposal Units

Stress Period	Stepwise Model #	Stress Period for Stepwise Model	Stress Period Length (years)	Stress Period Length (days)	Total Elapsed Years	Total Elapsed Days	Start Date	Finish Date
1	1	1	1	365	1	365	1/1/2018	12/31/2018
2		2	1	365	2	730	1/1/2019	12/31/2019
3		3	1	366	3	1096	1/1/2020	12/31/2020
4		4	1	365	4	1461	1/1/2021	12/31/2021
5		5	1	365	5	1826	1/1/2022	12/31/2022
6		6	1	365	6	2191	1/1/2023	12/31/2023
7		7	1	366	7	2557	1/1/2024	12/31/2024
8		8	1	365	8	2922	1/1/2025	12/31/2025
9	2	1	1	365	9	3287	1/1/2026	12/31/2026
10		2	1	365	10	3652	1/1/2027	12/31/2027
11		3	1	366	11	4018	1/1/2028	12/31/2028
12		4	1	365	12	4383	1/1/2029	12/31/2029
13		5	5	1826	17	6209	1/1/2030	12/31/2034
14		6	5	1826	22	8035	1/1/2035	12/31/2039
15		7	5	1827	27	9862	1/1/2040	12/31/2044
16		8	5	1826	32	11688	1/1/2045	12/31/2049
17		9	10	3652	42	15340	1/1/2050	12/31/2059
18		10	10	3653	52	18993	1/1/2060	12/31/2069
19		11	10	3652	62	22645	1/1/2070	12/31/2079
20		12	10	3653	72	26298	1/1/2080	12/31/2089
21		13	10	3652	82	29950	1/1/2090	12/31/2099
22		14	10	3652	92	33602	1/1/2100	12/31/2109
23		15	10	3652	102	37254	1/1/2110	12/31/2119
24		16	10	3653	112	40907	1/1/2120	12/31/2129
25		17	10	3652	122	44559	1/1/2130	12/31/2139
26		18	10	3653	132	48212	1/1/2140	12/31/2149

Model Results

Groundwater Elevation Relative to Ash Disposal Units

Figure 2 contains hydrographs at hypothetical monitoring points under the new ash disposal units to illustrate the simulated water table in relation to the bottom of the lined landfills. A 5-foot separation is maintained at all the landfill points throughout the simulation.

Solute Transport Results

Simulated plume concentrations, volume, and mass calculations should be considered as estimates due to uncertainty associated with model inputs, including source concentrations, seepage rates, and boron retardation. **Figures 3** through **6** present model simulated plume maps at the following time periods.

- End of 2049 (The end of the flushing and capture system operation), and
- End of 2149 (100 years after the cessation of the flushing and capture system operation).

The boron plume exists predominantly under the former A Pond footprint at the end of capture and injection shutdown at the end of 2049. The plume is virtually gone by the end of 2149.

Mass Removed

Mass discharge rates from wells were calculated from model results to help evaluate remedy performance. Mass discharge is a measure of the mass of constituent removed by a well and was calculated by multiplying the well pumping rate by the concentration of boron in the model cell. **Table 3** presents the predicted boron removal rate and total predicted mass removed for each capture system component from 2023 through the end of 2049.

Plume Mass and Volume

Model output was processed to calculate the total volume and mass of groundwater exceeding the cleanup criteria (CC) for boron (4 mg/L) at multiple times.

Table 4 presents the estimated volume and mass of groundwater exceeding the Cleanup Criteria for boron at the end of 2049 and the end of 2069. Relative to baseline, Alternative 4B results in 92 percent and 97 percent reduction in boron plume volume and boron plume mass by 2050. By 2069, Alternative 4B results in in 98 percent and 99 percent reduction in boron plume volume and boron plume mass.

Transect Mass Discharge

Transects around source areas help quantitatively assess the constituent mass migrating away from and through source areas. Mass discharge is a measure of mass per unit time crossing a transect. Mass discharge across transects was calculated from model results at the end of 2069. **Table 5** summarizes the predicted mass of boron crossing transect at the end of 2069 and indicates that the model predicts boron

mass discharge is below the CC at all transects by 2069 except B-B' and E-E' (**Figure 1**). Small portions of plume remain near transects B-B' and E-E' but are gone by the end of 2149. (**Figures 3** through **6**).

Comparison to Approved Remedy Results

The original Alternative 4 approved by DEQ in 2019, did not account for any leached constituents from CCR material, the original remedy focused on removing fugitive impacted process water. The previous Alternative 4 boron transport simulations likely underrepresented long term boron concentrations with closure in place.

Estimated volume and mass for the original approved Alternative 4 is also presented in **Table 4**. The plume volume percent reduction from baseline for the closure by removal (Alternative 4B) compared to the original Alternative 4 are within 5 percent for 2049 and 1 percent for 2069. The plume mass percent reduction from baseline for Alternative 4B compared to the original Alternative 4 are virtually equivalent.

Simulated boron transect mass discharge for the original approved Alternative 4 is presented in **Table 5** along with Alternative 4B results. Mass discharge at transect B-B' is estimated to be about 0.04 kilograms per day (kg/d) higher under Alternative 4B than originally simulated for Alternative 4. Mass discharge at transect E-E' is estimated to be about 0.004 kg/d lower under Alternative 4B than originally simulated for Alternative 4.

SUMMARY AND CONCLUSIONS

The boron plume in Alternative 4B – Closure-by-removal is limited to areas mainly under A Pond at the end of 2049 and is virtually gone by the end of 2149. The water table maintains a 5-foot separation distance with the bottom of the new landfills throughout the duration of the simulation.

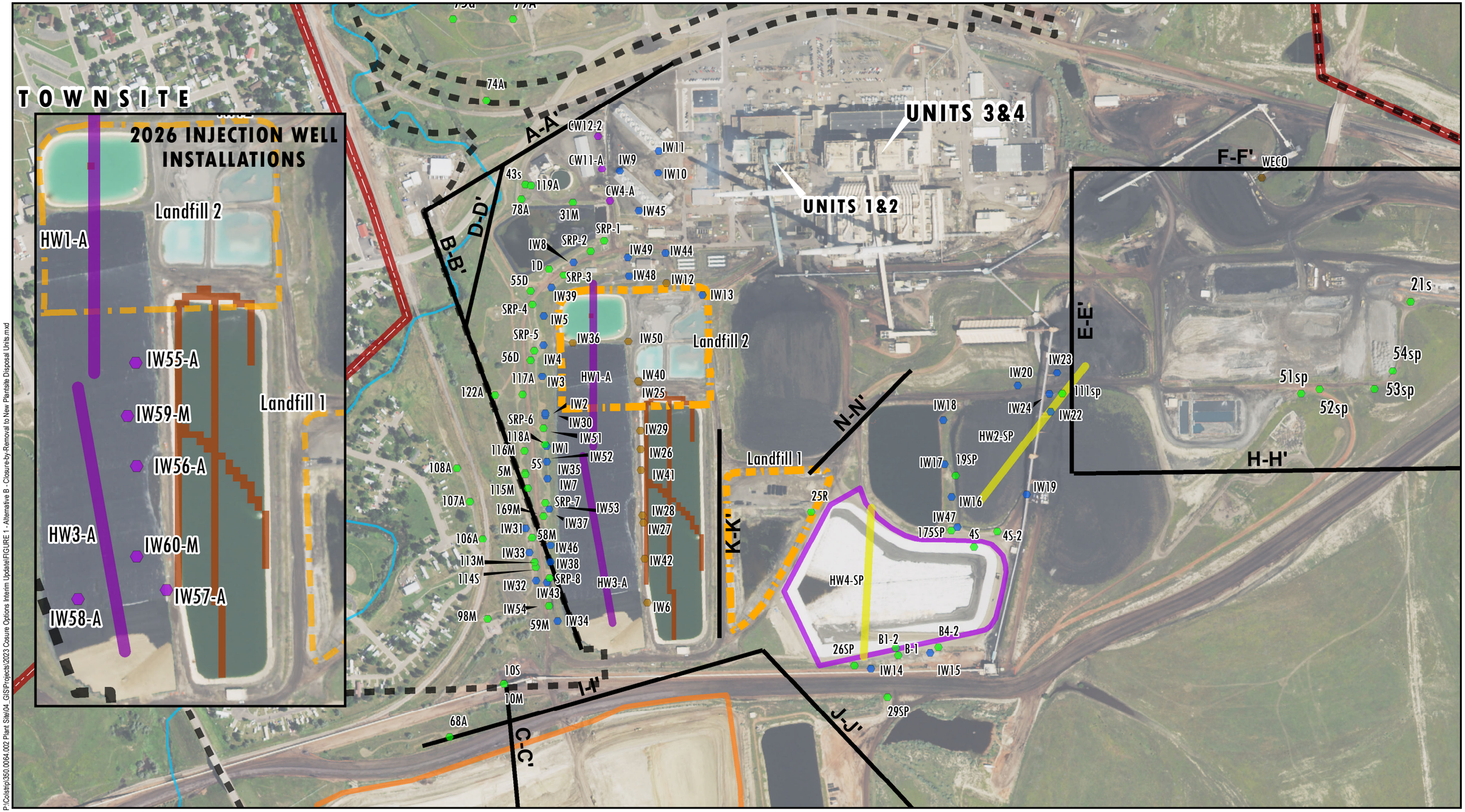
The reductions in plume volume and mass for Alternative 4B Closure by Removal are within 5 percent of the original DEQ approved Alternative 4.

REFERENCES

Canty, 2017. Cleanup Criteria and Risk Assessment Report, Wastewater Facilities Comprising the Closed-Loop System, Units 1 & 2 Stage I and II Evaporation Ponds Area, Colstrip Steam Electric Station, Colstrip, Montana. November 19.

NewFields 2019. APPENDIX J Plant Site Numerical Model Pilot Injection Test Calibration and Final Remedial Design Simulation. Technical Memorandum to: Gordon Criswell and Jennifer Petritz-Talen Montana LLC. October 1, 2019

FIGURES



P:\Colstrip\350.00064.002 Plant Site\04_GIS\Projects\2023 Cosure Options Interim Update\FIGURE 1 - Alternative B - Closure-by-Removal to New Plantsite Disposal Units.mxd

Note: 2019 NAIP Imagery

0 Feet 500

NewFields

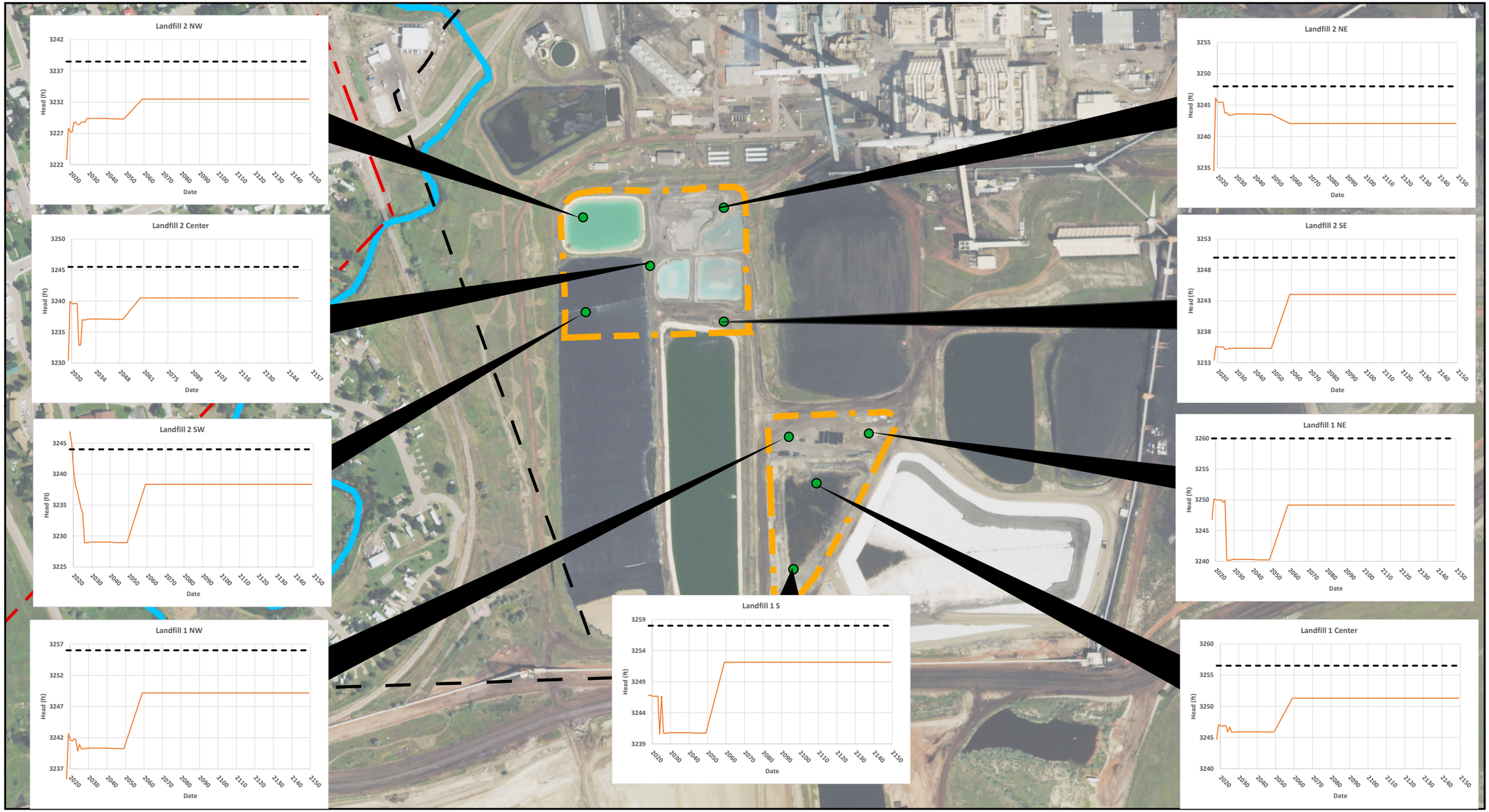
- New Ash Disposal Units
- Transects
- Capture Well
- Injection Well
- Decomissioned Injection Wells
- Replacement Inejction Wells

Horizontal Capture Well

- In Alluvium
- In Spoils

- Underdrain Collection System
- AOC Boundary
- Plant Property Boundary
- Brine Concentrator Solids Disposal Area
- Underdrain Sump
- Groundwater Capture Storage Pond

Alternative B - Closure by Removal to new Plant Site Disposal Units
Plant Site Closure Options Modeling
CSES-Colstrip, Montana
FIGURE 1



P:\Colstrip\350.0064.002 Plant Site\04_GIS\Projects\2023 Closure Options Interim Update\FIGURE 2 - Hydrographs of Water Levels Below Landfills.mxd

Note: 2019 NAIP Imagery

0 Feet 360

Areas Exceeding Cleanup Criteria (CC)

Simulated Water Table Elevation

Pond/Unit Bottom Elevation

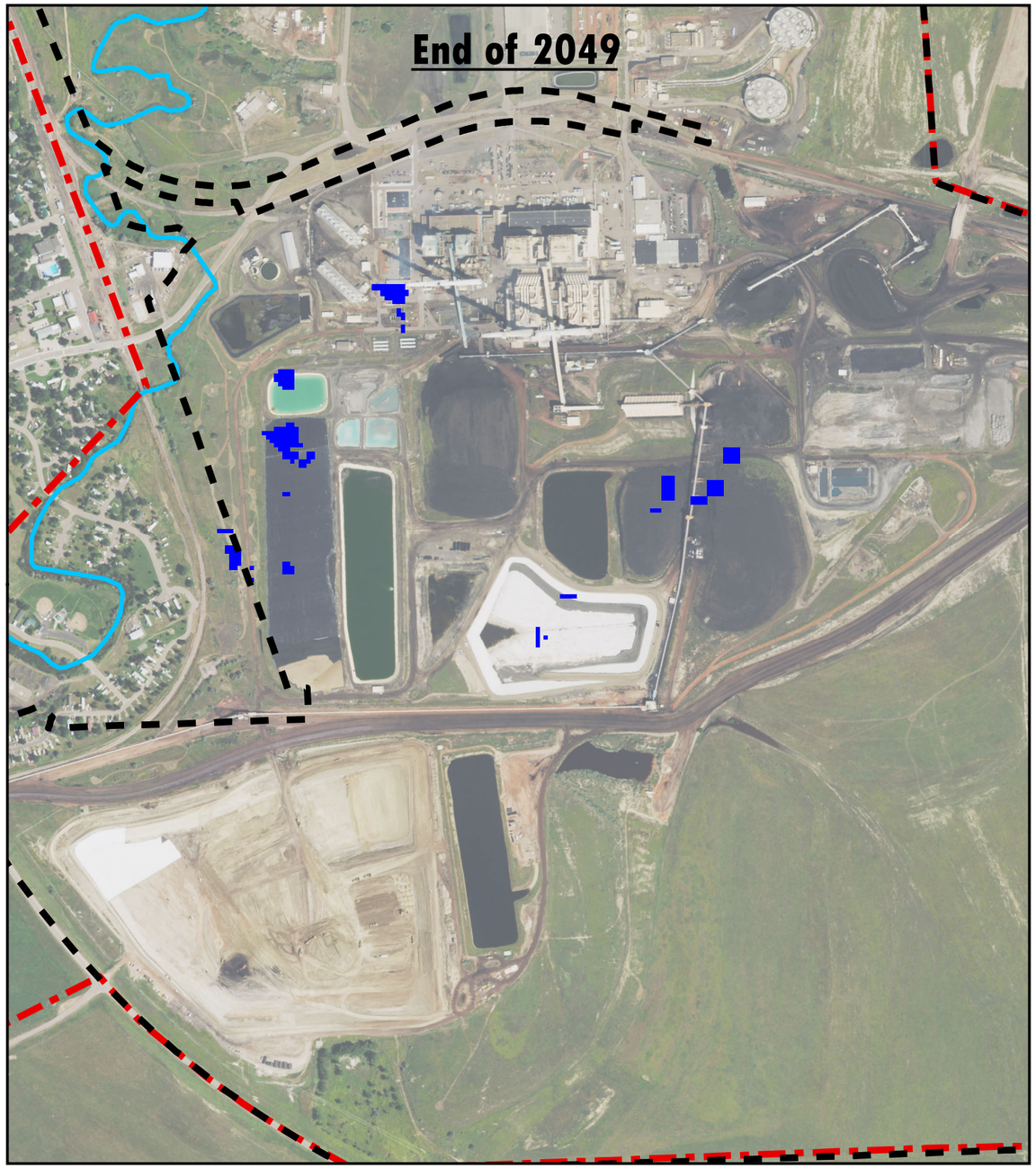
AOC Plant Site Boundary

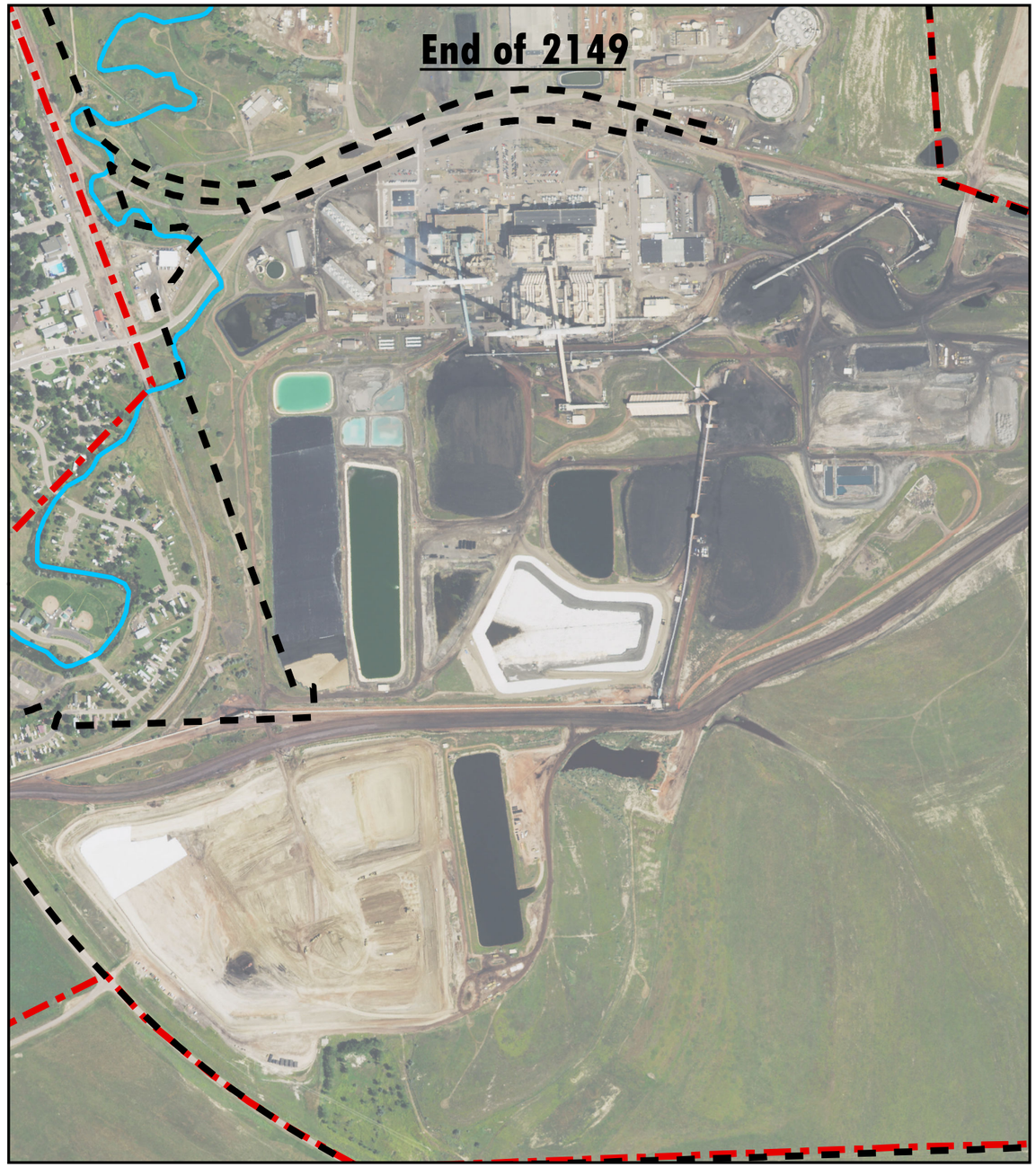
CSES Property Boundary

New Ash Disposal Units

NewFields

Hydrographs of Water Levels Below Landfills
Plant Site Clousre Options Modeling
CSES-Colstrip, Montana
FIGURE 2





P:\Colstrip\350.0064.002 Plant Site\04_GIS\Projects\2023 Cosure Options Interim Update\FIGURE 3 - Closure by Removal Areas of Exceedance 2050 and 2150 - Layer 1.mxd

Note: 2019 NAIP Imagery

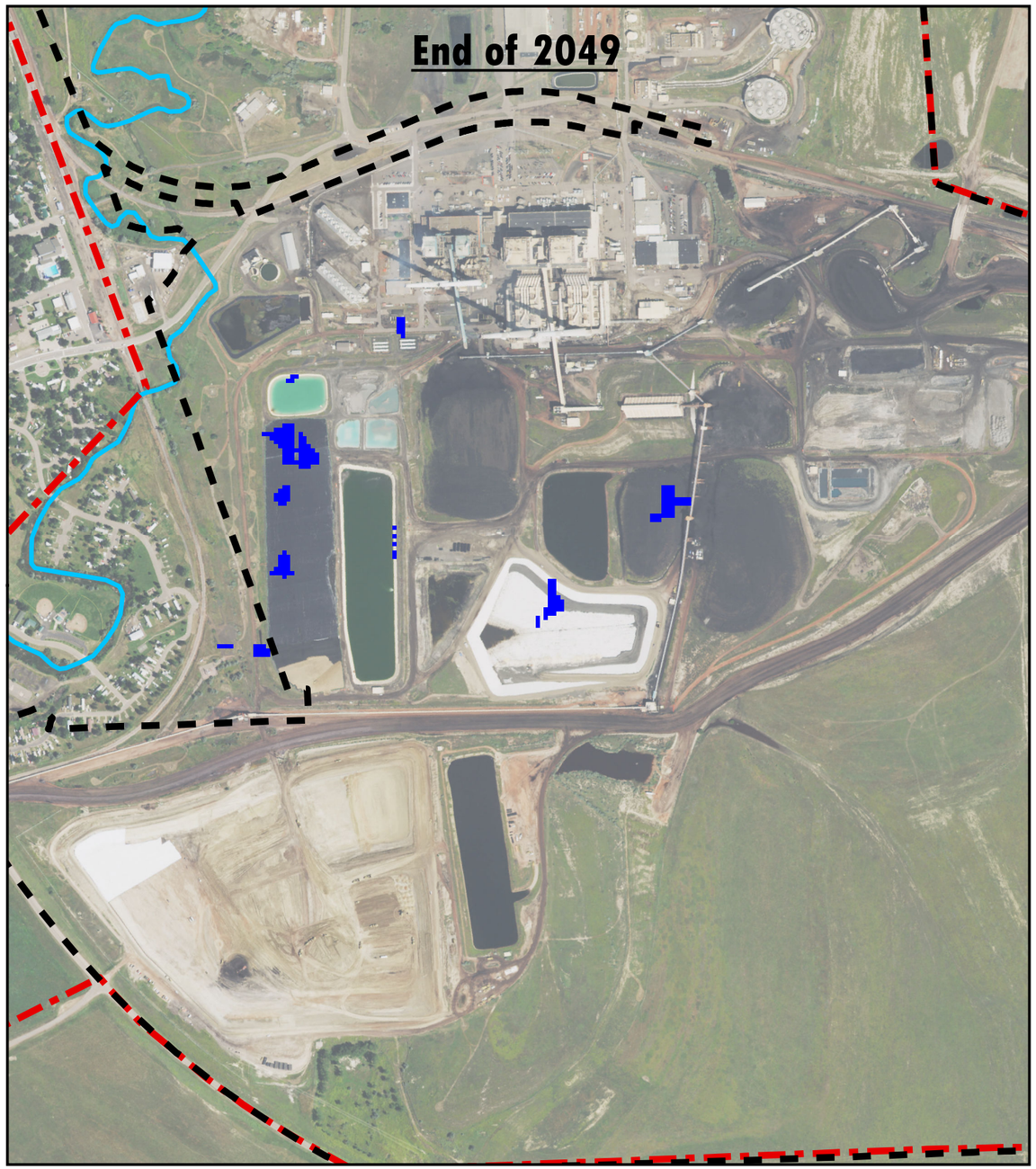
Areas Exceeding Cleanup Criteria (CC)

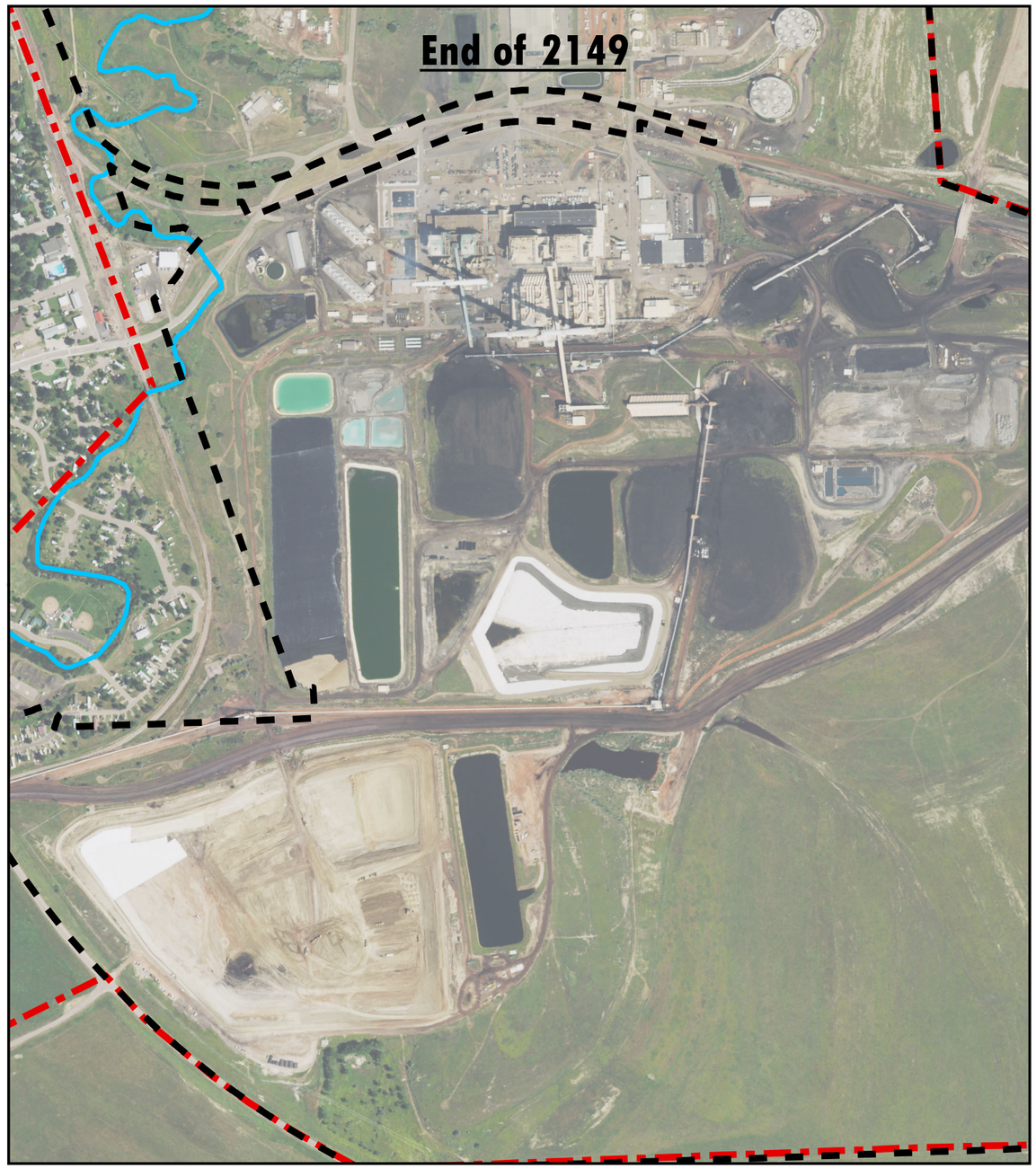
- Boron Exceeding CC
- AOC Plant Site Boundary
- CSES Property Boundary

0 Feet 720

NewFields

Closure by Removal Areas of Exceedance 2050 and 2150 - Layer 1
Plant Site Clousre Options Modeling
CSES-Colstrip, Montana
FIGURE 3





P:\Colstrip\350.0064.002 Plant Site\04_GIS\Projects\2023 Cosure Options Interim Update\FIGURE 4 - Closure by Removal Areas of Exceedance 2050 and 2150 - Layer 2.mxd

Note: 2019 NAIP Imagery

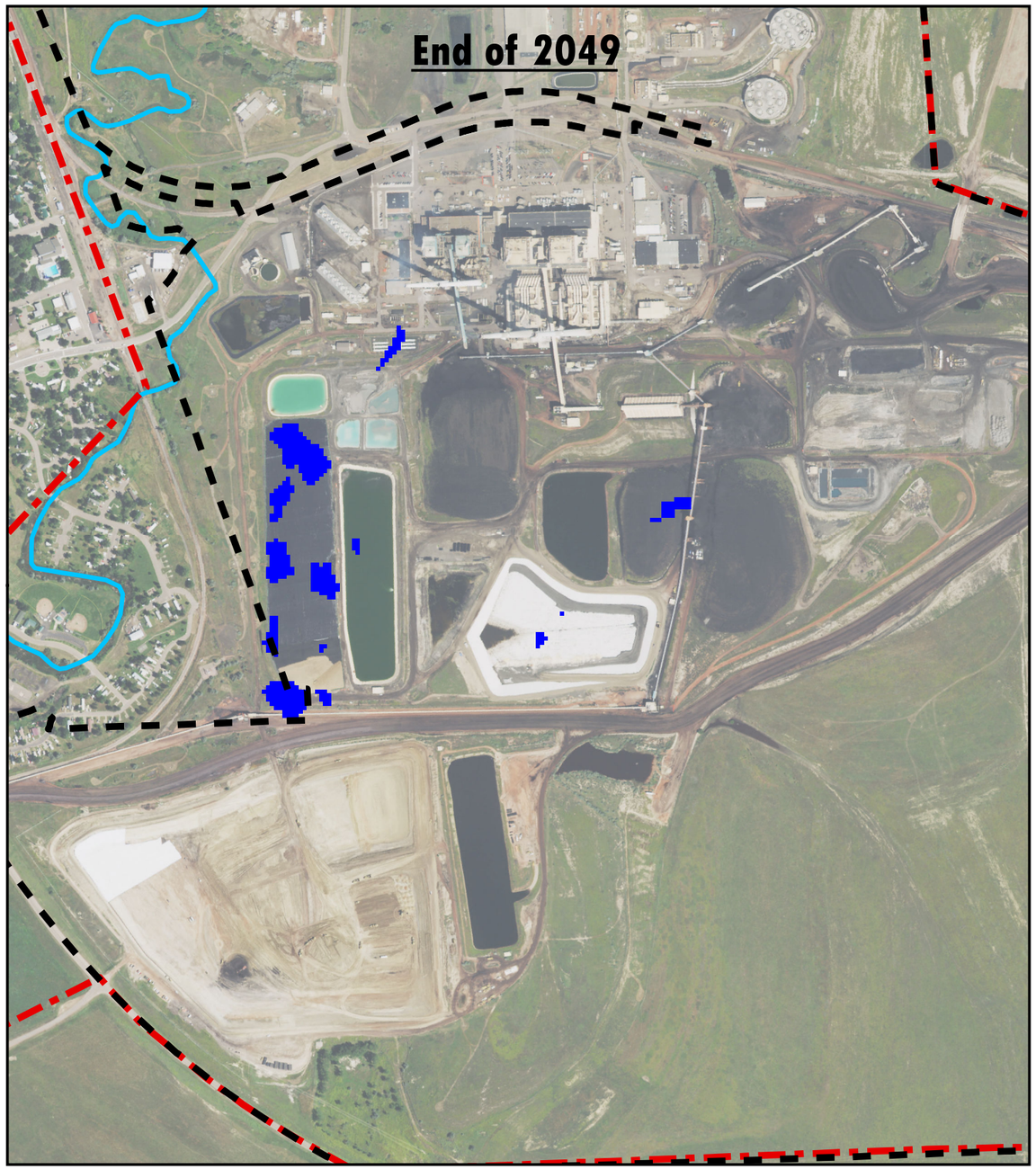
Areas Exceeding Cleanup Criteria (CC)

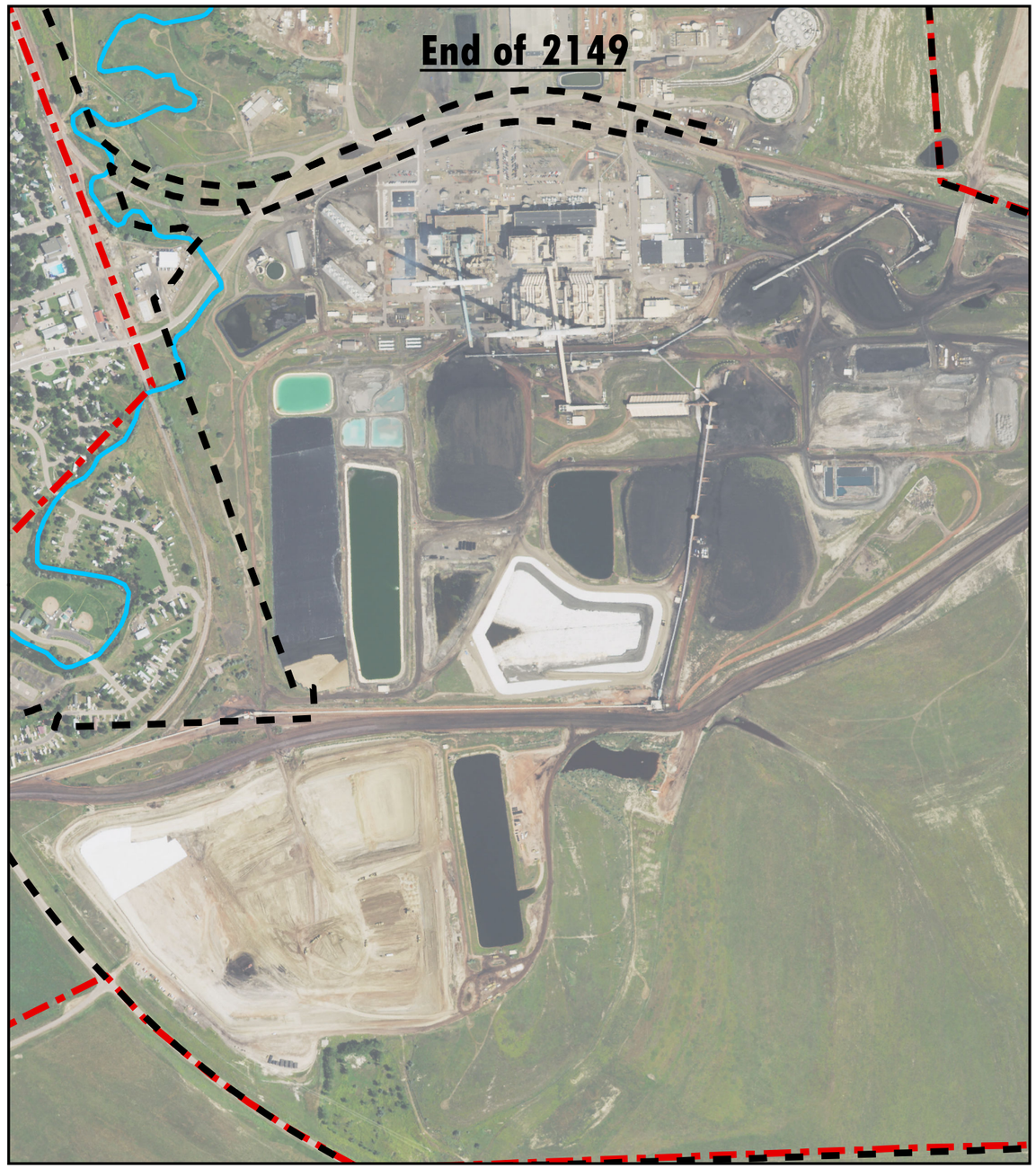
- Boron Exceeding CC
- AOC Plant Site Boundary
- CSES Property Boundary

0 Feet 720

NewFields

Closure by Removal Areas of Exceedance 2050 and 2150 - Layer 2
Plant Site Clousre Options Modeling
CSES-Colstrip, Montana
FIGURE 4





Note: 2019 NAIP Imagery

Areas Exceeding Cleanup Criteria (CC)

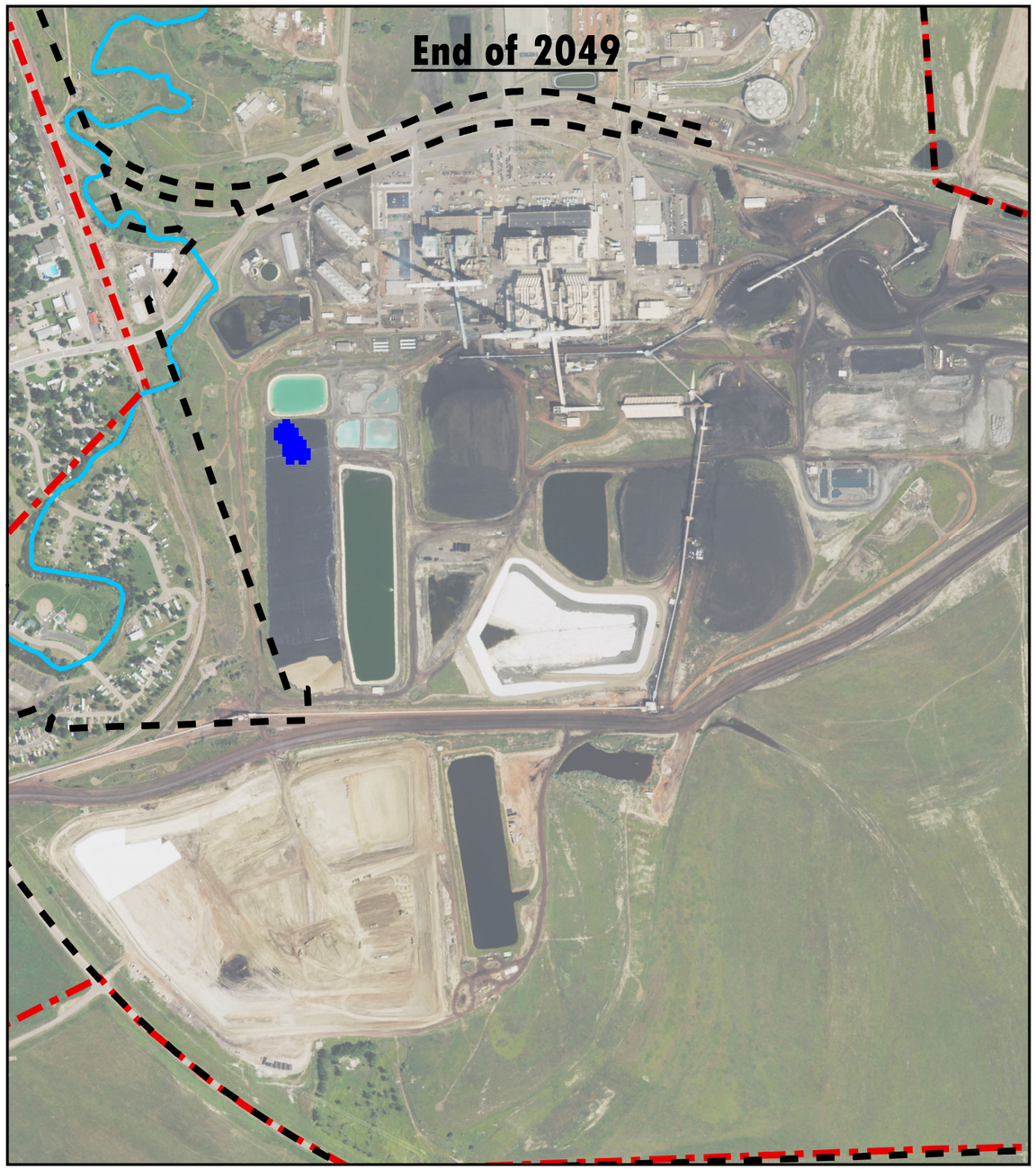
- Boron Exceeding CC
- AOC Plant Site Boundary
- CSES Property Boundary

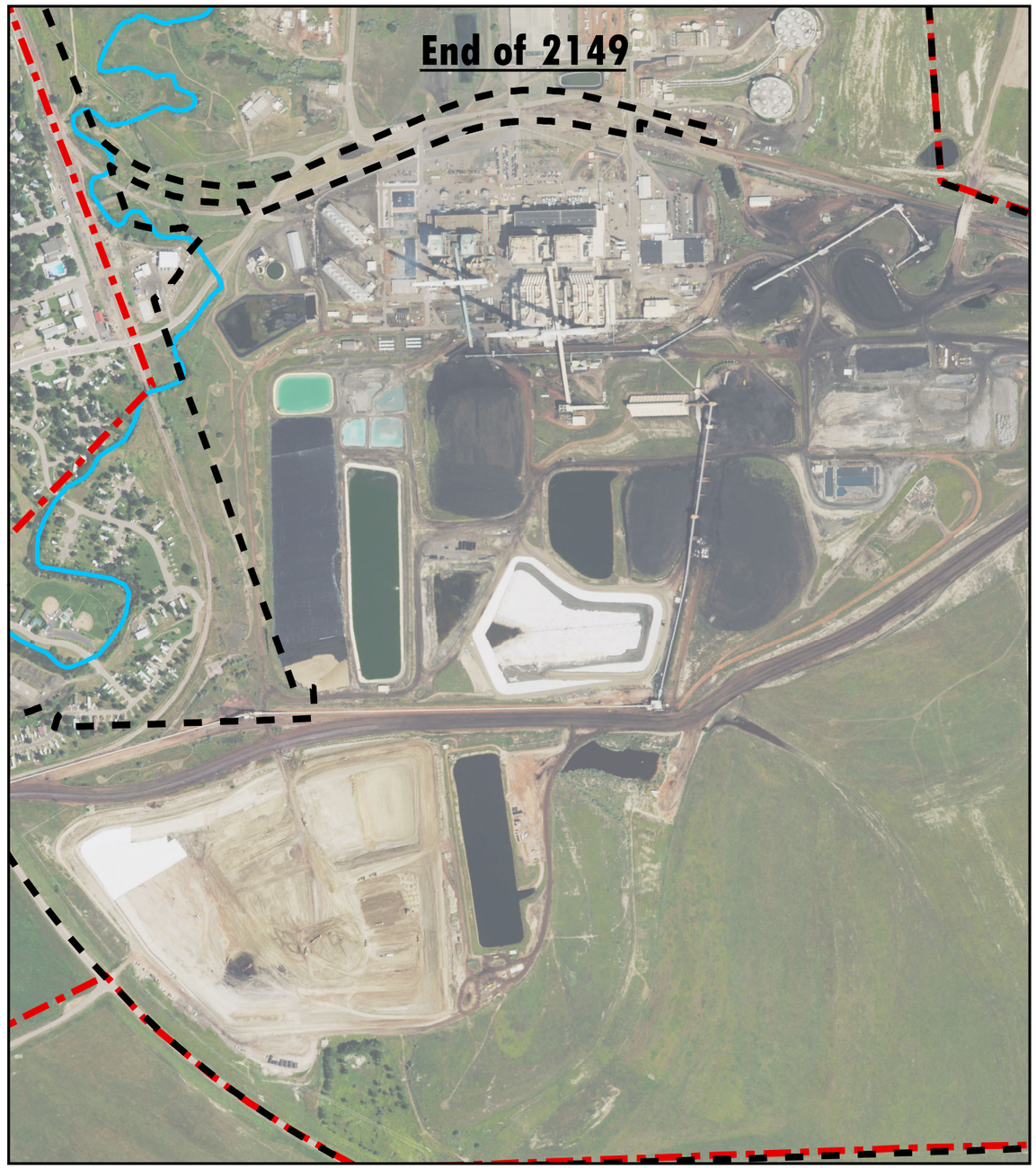
0 Feet 720

NewFields

Closure by Removal Areas of Exceedance 2050 and 2150 - Layer 3
Plant Site Clousre Options Modeling
CSES-Colstrip, Montana
FIGURE 5

P:\Colstrip\350.0064.002 Plant Site\04_GIS\Projects\2023 Cosure Options Interim Update\FIGURE 5 - Closure by Removal Areas of Exceedance 2050 and 2150 - Layer 3.mxd





Note: 2019 NAIP Imagery

Areas Exceeding Cleanup Criteria (CC)

- Boron Exceeding CC
- AOC Plant Site Boundary
- CSES Property Boundary

0 Feet 720

NewFields

Closure by Removal Areas of Exceedance 2050 and 2150 - Layer 4
Plant Site Clousre Options Modeling
CSES-Colstrip, Montana
FIGURE 6

P:\Colstrip\350.0064.002 Plant Site\04_GIS\Projects\2023 Cosure Options Interim Update\FIGURE 6 - Closure by Removal Areas of Exceedance 2050 and 2150 - Layer 4.mxd

TABLES

Table 3. Predicted Mass of Boron Removed by Wells - Alternative 4B

Well Name	Sub-Area	Boron Mass Removed (kg/d)											
		2023	2024	2025	2026	2027	2028	2029	2030-2034	2035-2039	2040-2044	2045-2049	2050-2149
106A	Off-site West Area	0	0	0	0	0	0	0	0	0	0	0	0
107A	Off-site West Area	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0
108A	Off-site West Area	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0
10M	Off-site West Area	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0
10S	Off-site West Area	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0
111SP	Central Source Area	0	0	0	0	0	0	0	0	0	0	0	0
113M	Off-site West Area	0	0	0	0	0	0	0	0	0	0	0	0
114S	Off-site West Area	0	0	0	0	0	0	0	0	0	0	0	0
115M	West Source Area	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0
116M	West Source Area	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0
117A	West Source Area	0	0	0	0	0	0	0	0	0	0	0	0
118A	West Source Area	0	0	0	0	0	0	0	0	0	0	0	0
119A	West Source Area	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0
122A	West Source Area	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0
130M	South Source Area	0	0	0	0	0	0	0	0	0	0	0	0
142R	South Source Area	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0
147A	South Source Area	0	0	0	0	0	0	0	0	0	0	0	0
169M	Off-site West Area	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0
175SP	Central Source Area	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0
19SP	Central Source Area	0	0	0	0	0	0	0	0	0	0	0	0
1D	West Source Area	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0
21S	East Source Area	0	0	0	0	0	0	0	0	0	0	0	0
25R	Central Source Area	0	0	0	0	0	0	0	0	0	0	0	0
26SP	Central Source Area	0	0	0	0	0	0	0	0	0	0	0	0
29SP	Central Source Area	0	0	0	0	0	0	0	0	0	0	0	0
31M	West Source Area	0	0	0	0	0	0	0	0	0	0	0	0
43S	West Source Area	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0
4S	Central Source Area	0	0	0	0	0	0	0	0	0	0	0	0
4S-2	Central Source Area	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0
51SP	East Source Area	0	0	0	0	0	0	0	0	0	0	0	0
52SP	East Source Area	0	0	0	0	0	0	0	0	0	0	0	0
53SP	East Source Area	0	0	0	0	0	0	0	0	0	0	0	0
54SP	East Source Area	0	0	0	0	0	0	0	0	0	0	0	0
55D	West Source Area	0	0	0	0	0	0	0	0	0	0	0	0
56D	West Source Area	0.09	0	0	0	0	0	0	0	0	0	0	0
58M	West Source Area	0.01	0.01	0.01	0.01	0.01	0.01	0	0	0	0	0	0
59M	Off-site West Area	0	0	0	0	0	0	0	0	0	0	0	0
5M	West Source Area	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0
5S	West Source Area	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0
68A	Soutwest Distal Area	0	0	0	0	0	0	0	0	0	0	0	0
6M	South Source Area	0	0	0	0	0	0	0	0	0	0	0	0
704	Townsite	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0
725	Townsite	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0
729	Townsite	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0
70SP	Central Source Area	0	0	0	0	0	0	0	0	0	0	0	0
74A	North Distal Area	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0
75A	North Distal Area	0	0	0	0	0	0	0	0	0	0	0	0
78A	West Source Area	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0
79A	North Distal Area	0	0	0	0	0	0	0	0	0	0	0	0
82A	North Distal Area	0	0	0	0	0	0	0	0	0	0	0	0
98M	Off-site West Area	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0
9M	South Source Area	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0

Table 3. Predicted Mass of Boron Removed by Wells - Alternative 4B

Well Name	Boron Mass Removed (kg/d)												
	Sub-Area	2023	2024	2025	2026	2027	2028	2029	2030-2034	2035-2039	2040-2044	2045-2049	2050-2149
B-1	Central Source Area	0	0	0	0	0	0	0	0	0	0	0	0
B1-2	Central Source Area	0	0	0	0	0	0	0	0	0	0	0	0
B4-2	Central Source Area	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0
CW11-A	Central Source Area	0	0	0	0	0	0	0	0	0	0	0	0
CW12-2	Central Source Area	0.01	0.01	0.01	0.01	0.01	0	0	0	0	0	0	0
CW4-A	West Source Area	0.01	0.01	0	0	0	0	0	0	0	0	0	0
SRP-1	West Source Area	0	0	0	0	0	0	0	0	0	0	0	0
SRP-2	West Source Area	0	0	0	0	0	0	0	0	0	0	0	0
SRP-3	West Source Area	0.13	0.10	0.08	0.07	0.07	0.06	0	0	0	0	0	0
SRP-4	West Source Area	0	0	0	0	0	0	0	0	0	0	0	0
SRP-5	West Source Area	0	0	0	0	0	0	0	0	0	0	0	0
SRP-6	West Source Area	0	0	0	0	0	0	0	0	0	0	0	0
SRP-7	West Source Area	0	0	0	0	0	0	0	0	0	0	0	0
SRP-8	Off-site West Area	0	0	0	0	0	0	0	0	0	0	0	0
HW1-A	West Source Area	0.84	0.55	0.53	0.34	0.34	0.35	0.37	0.29	0.21	0.16	0.12	0
HW2-SP	Central Source Area	1.0	0.97	0.92	0.87	0.83	0.79	0.76	0.64	0.55	0.48	0.43	0
HW3-A	West Source Area	0.36	0.28	0.27	0.45	0.45	0.43	0.42	0.29	0.20	0.14	0.11	0
HW4-SP	Central Source Area	0.44	0.40	0.37	0.34	0.32	0.30	0.29	0.22	0.18	0.14	0.12	0
Underdrain	West Source Area	0.79	0.21	0.21	0.37	0.34	0.32	0.31	0.25	0.21	0.18	0.15	0
Sum of Mass Removed		3.9	3.29	3.15	3.04	2.96	2.88	2.76	2.35	2.04	1.81	1.67	0

Notes:

kg/d = kilograms per day

Table 4. Predicted Volume and Mass of Groundwater Exceeding Boron CC

Volume Exceeding Boron CC (Acre Feet)					
Layer	Baseline (2018)	Alternative 4		Alternative 4B	
		End of 2049	End of 2069	End of 2049	End of 2069
Total	349	21	8	27	8
Percent Reduced from Baseline	0	94%	98%	92%	98%

Mass Exceeding Boron CC (kilograms)					
Layer	Baseline (2018)	Alternative 4		Alternative 4B	
		End of 2049	End of 2069	End of 2049	End of 2069
Total	5,348	141	47	162	46
Percent Reduced from Baseline	0	97%	99%	97%	99%

Note:

Volume and mass estimates were calculated as the volume/mass of groundwater above the Proposed Cleanup Criteria (CC) of 4 mg/L.
Negative percentage indicates an increase in volume or mass from baseline.

Table 5. Predicted Mass Discharge of Boron at Transects end of 2069

Simulation	Year	Mass Discharge of Boron (kg/d)													
		A-A'	B-B'	C-C'	D-D'	E-E'	F-F'	G-G'	H-H'	I-I'	J-J'	K-K'	L-L'	M-M'	N-N'
Alternative 4	End of 2069	1.87E-01	7.18E-02	5.11E-02	1.25E-01	1.42E-02	2.95E-03	1.94E-02	8.88E-03	8.97E-02	3.63E-02	2.60E-02	9.7E-04	8.95E-03	1.53E-02
Alternative 4B	End of 2069	2.31E-01	1.14E-01	5.92E-02	1.43E-01	1.05E-02	6.43E-03	1.75E-02	1.16E-02	1.08E-01	4.27E-02	4.84E-02	5.7E-04	8.50E-03	3.30E-02

Notes:

Shaded cells indicate all concentrations are below the Cleanup Criteria at the transect